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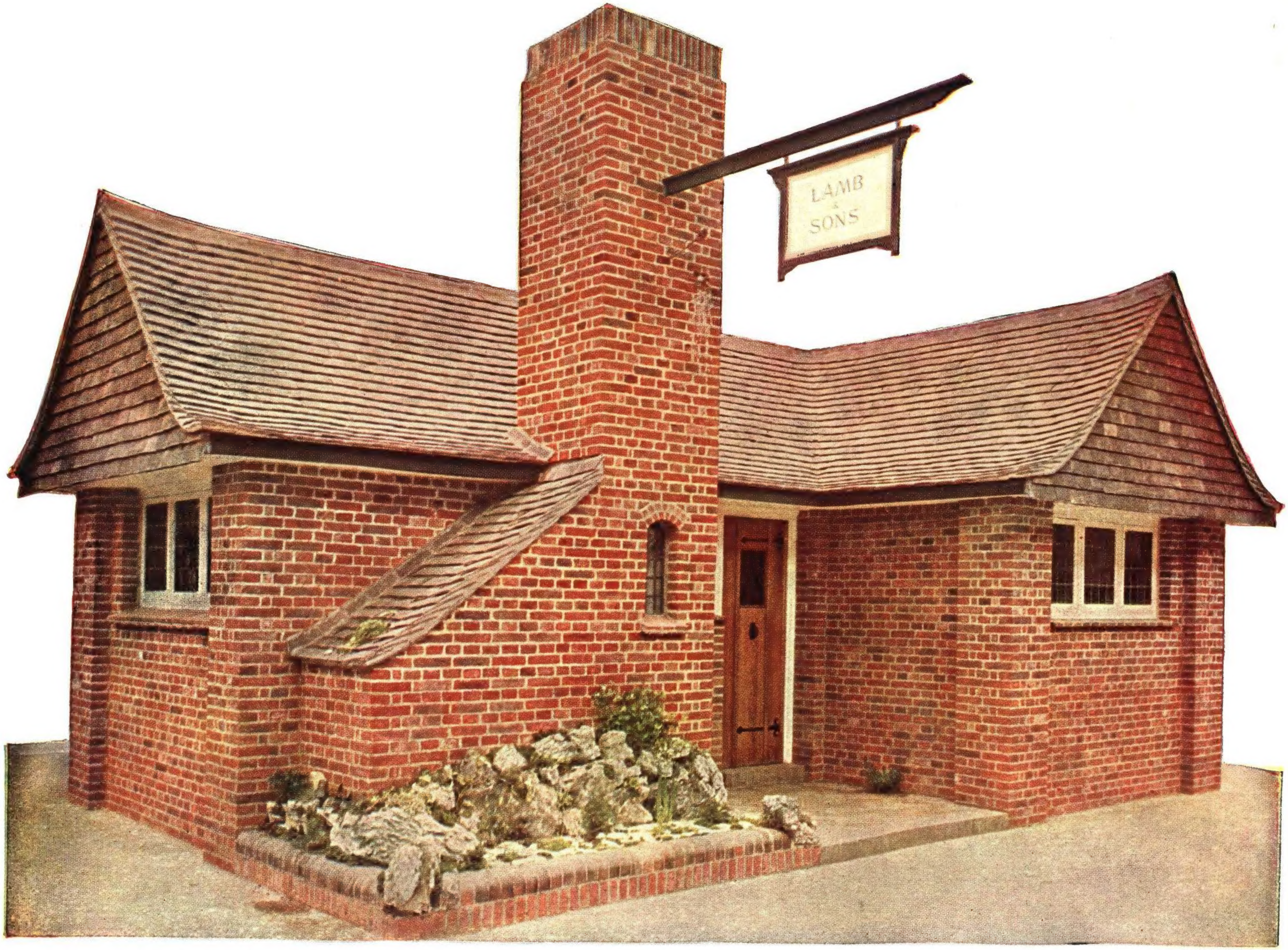

EXAMPLE OF ASSORTED COLOUR BRICKWORK, WITH TILE ROOFING AND TILE HANGING AT GABLE ENDS.

Bricks and tiles by Lamb & Sons.

[*Frontispiece*

THE MODERN BRICKLAYER

A PRACTICAL WORK ON BRICKLAYING IN ALL ITS BRANCHES

WITH
SPECIAL SECTIONS ON
TILING AND SLATING, SPECIFICATIONS,
ESTIMATING, Etc. Etc.

BY
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VOLUME I

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PREFACE

INCREASED skill is demanded in modern brickwork, which is more in favour than ever. There has been much progress of late years, corresponding with improvements in the manufacture of bricks and tiles and new theories as to mortars. These facts justify the issue of THE MODERN BRICKLAYER, which is the work of a practical craftsman, who has also enjoyed the advantage of considerable experience in teaching his trade in various schools. He has had the assistance of experts in certain of the sections.

The book is at once comprehensive and detailed, dealing progressively with every branch of brickwork and tile laying. It will be found that problems are discussed about which it is extremely difficult to obtain information elsewhere. A series of chapters on the business side of the trade will be found very useful. The book has been planned so as to enable the bricklayer to become a master of his subject from beginning to end.

THE GENERAL EDITOR.

CONTENTS

VOL. I

CHAPTER I

PAGES

INTRODUCTORY 1–4

CHAPTER II

BRICKS AND THEIR VARIETIES 5–16

CHAPTER III

MORTARS 17–32

CHAPTER IV

TOOLS AND APPLIANCES 33–43

CHAPTER V

PRELIMINARY CONSIDERATIONS 44–55

CHAPTER VI

THE BONDS 56–81

CHAPTER VII

FOUNDATIONS AND FOOTINGS 82–101

CHAPTER VIII

JUNCTION WALLS 102–111

CHAPTER IX

PAGES
ANGLES 112–136

CHAPTER X

PIERS, REVEALS, AND JAMBS 137–148

CHAPTER XI

JOINTING AND POINTING 149–160

CHAPTER XII

FIREPLACES AND CHIMNEYS 161–179

CHAPTER XIII

THE DOMESTIC COPPER 180–185

CHAPTER XIV

WINDOW AND DOOR OPENINGS 186–196

CHAPTER XV

PARTITIONS AND FLOORS 197–205

CHAPTER XVI

WINTER BRICKLAYING 206–209

CHAPTER XVII

SAND COURSES 210–213

FULL-PAGE PLATES

VOL. I

EXAMPLE OF ASSORTED COLOUR BRICKWORK, WITH TILE ROOFING AND TILE HANGING AT GABLE ENDS . . . *Frontispiece*

FACING PAGE

PLACING QUOIN BRICKS IN A SQUARE ANGLED WALL WITH STOPPED ENDS 34

BRICKLAYER'S TOOLS, I 36

BRICKLAYER'S TOOLS, II 40

BRICKLAYERS SETTING OUT WORK 50

LEVELLING WITH 3-FOOT LEVEL TO OBTAIN HORIZONTAL LEVEL FROM QUOIN TO STOP END BRICK 120

PLUMBING FOR CORRECT POSITION OF QUOIN WITH PLUMB-RULE AND LEAD-BOB 124

CONSTRUCTION OF A SQUINT PIER 132

GLAZED BRICK AND TILE FIREPLACE 160

BRICK CHIMNEYPIECE AND KERB IN "TUDOR" STYLE . . 162

PARGETING CHIMNEY FLUES 168

THE HANDLING OF TOOLS IN THE CONSTRUCTION OF A CHIMNEY STACK WITH VARIED PROJECTIONS 172

JOINTING AND POINTING WALL WITH ARCHED OPENING . . 194

ENTRANCE TO MARTIN'S BANK, BEXLEY HEATH 198

THE MODERN BRICKLAYER

VOL. I

CHAPTER I

INTRODUCTORY

Present-day Developments based on Art and Science—Antiquity of the Craft—The Need for Study—Scope and Plan of the Book.

Bricklaying may be either a mere form of manual labour or a highly developed craft, implying a knowledge of the principles of construction and an appreciation of art. The one is a poor thing, leading its practitioner nowhere, while the other is a matter of pride, opening up great possibilities to the man of patience and skill. However, craftsmanship must not be regarded as solely connected with the finer operations of gauged work—it is quite as much concerned with straightforward, good, sound laying of bricks. For it is the thought and care that are put into the work which raise it to a skilled craft.

That fair appearance appealing pleasantly to the eye coincides with sound, durable construction is abundantly proved by the great wealth of old brickwork still remaining with us in England, some dating back to the Roman and Norman times, far more to the Tudor, Stuart, and Georgian periods.

It must be remembered that over very wide areas of these islands, brick and brick-clay products are the natural, most economical, and most suitable of building materials. The clays and brick earths are very widely distributed, varying greatly, thus affording considerable variety in texture, colour, and other qualities. Hence we find that bricks and tiles were used here from very early days. The Romans in Britain made rectangular bricks 18 inches long by 12 inches wide and 2 inches thick. But more commonly they used a tile brick, to give a large bedding surface though triangular in form and rarely more than 1 inch thick. Specimens of both types, and even courses in their original setting, may be found in old Saxon and Norman churches and fortress walls. The Norman bricks and those of the Tudor and Stuart days were smaller than those of the Victorian and our own times. We can see both in Gothic and Renaissance work what excellent use was made of these alone or in conjunction with rubbed and cut brick and moulded terra-cotta.

This old work is mentioned here for two reasons. It shows that bricklaying is an ancient traditional craft with us, carried on with superb structural skill and with fine artistic feeling, a craft which assuredly should not be neglected by us now. This is all the more apparent from my second reason, which is that once more architects and the public are appreciating the peculiar merits of good brickwork, so that it is coming into its own again. Not that bricklaying has ever been abandoned, or failed to occupy the primary place for general building operations, but once again the desire is shown for beautiful brickwork in most types of buildings. Now, this revival in the favour of brick as an economical, sound, and handsome building material makes it incumbent for the bricklayer to be a true craftsman.

Many people are too apt to assume that it is an easy matter to lay bricks. But that is not so. It is by no means as easy as it looks. Even the mere picking up of bricks, manipulating the trowel, and pressing down the bricks in the mortar require some dexterity, though these are the most elementary of performances. The truth is bricklayers are not made in a day, even if they be Cabinet Ministers. It requires a well-planned training, perseverance, intelligent appreciation of whys and wherefores, and above all experience. For, apart from ease in handling the trowel and brick, the dexterous bedding of the latter, there are the questions of the perpends, angles, and return walls, the keeping to the bonding in hand, the preparation of, selection, and appropriate introduction of bats, quarter or three-quarter bricks, to complete a course. And then beyond these elements of the craft there are the advanced steps in the setting of bricks for reveals to window and other openings, the laying of sills and arched lintels, arched work generally, barrel vaulting with the niceties of laying bricks for piers, for projecting or recessed panelling, corbelling, and a hundred-and-one other things which go to make up the complete bricklayer. Clearly, then, it is an important business and an art. An important business because competent bricklaying is needed for sound, durable construction, an art because such competent work must be based on definite principles and when well carried out is pleasing to gaze upon because while fulfiling its rightful purpose it has a true æsthetic value.

With the revival in favour of exposed brickwork for both business and what has been termed luxury building has naturally come a closer study of the brick both as an ideal material for modern purposes of construction and as a material possessing undoubtedly outstanding artistic possibilities. This has in turn fostered a desire for better work and therefore resulted in more exacting demands on the craftsman. Nowadays architect, builder, and property owner all are seeking for men with the skill and taste displayed by their forerunners who, centuries ago, created the beautiful brick buildings of the Tudors, Jacobeans, and early Georgians. What was done then can be repeated now, not necessarily copies, but in the same spirit of fitness and striving after perfection.

We have only to look around us and consider the better class of work being put up, the numerous interesting experiments being made, to realise that this is the case. It is satisfactory to know that the level of technical instruction has been raised to meet this steadily and rapidly developing demand and so fit the candidates for the increasingly stringent requirements of present-day examiners and certifying authorities. It is only by study combined with practice that the bricklayer can succeed in becoming a craftsman and so qualify himself to fulfil the higher duties connected with his trade.

Admittedly this is no easy task, for if bricklaying is an art, it is also a science, as we have to acknowledge both when we consider the more difficult branches of architectural construction or the many paths of engineering—civil, sanitary, and industrial, in all of which now much is expected from the bricklayer.

So without exaggeration we may claim that bricklaying is a live and growing craft, for which fresh outlets are being constantly opened up, naturally entailing renewed efforts on the part of the craftsman, who must either advance in knowledge and adaptableness or hopelessly lag behind in the race of life. He must study the works of the past, keep abreast of current practice and progress and be alert as to hopes for the future. For a great deal is being done on the building site, in the schools and in the research laboratories, all of which concerns the intelligent craftsman.

A good deal of what is being done in these several fields is touched upon in this book, for they have their practical bearing on actual practice. How intimately this may be so, even when what appear to be rather remote investigations are in question, may be instanced by certain tests recently carried out by the Industrial Fatigue Research Board. The experiment dealing with the " physiological cost " of wheeling a barrowful of bricks was undertaken by Dr. G. P. Crowden, of the Physiological Department, University College, London, and he found that provided they were properly balanced, and that the load was adjusted to the stature of the barrowman, the cost for a load of 70 bricks was less than for a load of either 50 or 60 bricks. Starting and stopping the barrow in a 50-metre run was responsible for 29·3 per cent. of the oxygen consumption, of which 7·75 per cent. was used in raising and lowering the handles. The mean relative values of the " physiological cost " of wheeling the loaded barrow at various rates were : Slow walk, 1·12 ; normal brisk walk, 1 ; very quick walk, 1·68 ; and gentle run, 1·58. As the result of the experiments, certain improvements in barrow design had been suggested, including the lengthening of the legs to 18 inches or 20 inches.

So we see that what appeared to be a purely scientific experiment led to practical results. The same thing is repeatedly occurring in connection with the investigations of the Building Research Board, notable access of knowledge having accrued as regards the constitution of bricks and the suitability of different kinds of mortar. These facts concern the craftsman quite as intimately as they do the architect or the builder and show the necessity for keeping in touch with passing events, whether at home or abroad.

It will be found that this book has been planned on the lines suggested by the foregoing remarks. It is essentially a practical treatise written by a man steeped in the intricacies of the living craft, and whose later experiences as a teacher enables him to appreciate the difficulties of others, to expound the methods of work in detail and reasoned sequence. Assisted by experts he has placed before the reader a complete view of the craft, from start to finish. It would have been tempting to dwell at greater length on the historical and artistic sides of the subject, to have dealt with the development and fine achievements of the past, studies in themselves full of practical hints; but beside the fact that there are several excellent recent books on these aspects, the aim here is to provide a comprehensive guide to actual operations as carried on in the practice of to-day.

We have, therefore, a series of chapters which take the reader step by step from the production and selection of the brick and mortar through the many-sided activities of the bricklayer to the final touches in the embellishment of a great building and to the restoration thereof.

It is also in keeping with the plan that all forms of terra-cotta as a building material (which may be regarded as an exalted form of the purpose-made brick), hollow bricks or brick earth blocks, as well as tile and tile setting, should be included in the scheme, for these are materials that must be dealt with more or less constantly by the builder in bricks. So they receive equally systematic attention and their use alone or in combination with ordinary bricks is fully illustrated.

While each chapter is a treatise in itself, a monograph, as it were, which can be referred to on special points, they are also interdependent, forming a regular sequence, each one bearing on the other and requisite for the formation of the thorough craftsman. These volumes constitute more than a plain statement of facts, they provide a critical survey designed to assist in the solving of common practice problems. The same guiding rule has been observed in the selection of the numerous diagrams and other illustrations, all of which have a direct bearing on and help to elucidate the text.

THE EDITOR.

CHAPTER II

BRICKS AND THEIR VARIETIES

Raw Materials and Manufacture—Varieties : Rubbers, Cutters, Stocks, Flettons, Leicester and Local Reds, Suffolk Whites, Gaults, Malms, Stafford Blues, Dutch, Adamantine, Clinkers, Fire and Refractory, Carborundum, Scratch-faced, Purpose-made, Fixing, Air, Veneered, Sand-lime, Cement-concrete, Glazed, Hollow or Cavity Bricks, Hollow Brick Blocks—Defects in Bricks—Colour—Standard Sizes—Weight—Strength of Brick Piers—Absorption—Transmission of Heat.

BRICKS, for the most part, are made from brick earths, varieties of clay found widely dispersed over the country. These brick earths differ greatly in composition and colour and so give finished products of very unequal qualities, both as to physical characteristics and colours.

RAW MATERIAL AND MANUFACTURE

It is not necessary to go deeply into the processes of manufacture. We shall refer to these merely for the sake of enabling the variations of building bricks to be better understood.

Good brick earths should contain silica and alumina in notable proportions, associated in different kinds with lime, magnesia, and oxides (chiefly iron, which, like lime, has a great influence on colour). Loam and vegetable matter should be removed by " unsoiling " or removal of the top agricultural layer. The brick earth is then broken up to be " weathered " (exposed to the air), when stones, etc., are removed by hand picking or washing. The next process is pugging in a pugging mill, when often admixture of different descriptions of clays takes place. It is then ready for the brickmaker, who produces two main classes, hand-moulded and machine-made.

Hand-moulded bricks are generally more highly appreciated by architects, and all who desire artistic exposed brickwork. There are two principal kinds of hand-made bricks : (1) slop-moulded, in which the mould is wetted by dipping, giving a smooth surface ; (2) sand-moulded, in which the mould is dipped in sand, giving us the sand-faced bricks, differing according to the nature of the sand used.

Machine-made bricks are usually more uniform in appearance and accurate in size than the hand-made. They are also divided into two broad classes : (1) " soft-moulded," or " box-moulded," which may be either " wire cut," smooth faced and sharp edged, or " rusticated " with rough surface, often imitating sand-faced varieties ; (2) " stiff " and " semi-plastic " pressed bricks, which are heavy and compact. These are also given rusticated and sand-faced surfaces. Another admired finish is the tapestry face.

Both hand- and machine-made bricks may be perfect cubes, flat on all six faces, or may be recessed on one face—the recess being known as the frog. Some " wire-cut " bricks have frogs on both faces. The arris is the edge of the brick.

After moulding, the bricks are placed on racks to be air dried before being stacked in the kiln. The firing process is one of the most important, as upon it depends the quality of the brick, and to some extent the colour.

A well-made brick should be uniformly burned, free from stones or lumps, cracks or other flaws, have flat faces, sharp edges, be hard, and render a ringing sound when struck. It should cut with a straight smooth face, and not crumble or break irregularly.

The best bricks are known as " firsts," the second best as " seconds." Well-burned but ill-shaped bricks are known as " shippers," and are only fitted for rough work. " Hard stock " are slightly overburnt bricks, suitable for garden walling. " Burrs " are masses of vitrified bricks, sometimes used for rough walling or fancy garden work. " Grizzles " and " place bricks " are overburnt, and of very little use, while " chuffs " are bricks on which rain has fallen during the process of drying or firing, and being badly cracked are only serviceable for garden rubble.

Varieties of Bricks

There are many varieties of bricks, and new kinds are constantly being brought forward, but the following list describes the principal classes, outside of the local modifications of the main types.

Rubbers or ***Cutters*** are fine-grained bricks, usually red, suitable for cutting and carving, and also for moulding into *purpose-made* bricks (see below). Two of the best known are Fareham reds and Lawrence's Bracknells.

Stocks are sound, hard, yellow to reddish, much used for general work in the London district and the Home Counties.

Flettons are light pink, compact, of uniform size and colour.

Leicester reds are hard, dense, pressed-facing bricks of good colour.

Local reds are usually hand made and vary greatly in physical qualities, in colour from buff pinks to purple reds, according to the nature of the clay in each district.

Suffolks, known as *whites*, are of a creamy hue, not very hard, but esteemed for axed work.

Gaults are hard white bricks, difficult to cut, having a high resistance to crushing strain and low absorption. They are largely used for air bricks.

Malm bricks are kiln-burnt bricks from malm ; of medium quality for ordinary work.

Staffordshire blues are hard, dense, and of low absorptive nature, so are largely used for foundations, and where great strength is required.

Dutch, adamantine or ***clinkers***, are very hard and commonly used for paving.

Firebricks are made from special clays. They are compact, hard, and resist great heat, and so are used for lining chimneys, shafts, furnaces, etc.

Refractory bricks are firebricks of a higher grade, which will not fuse or crumble under very high temperatures, and so are employed in high-temperature furnaces and similar work.

Carborundum bricks are one of the most useful description of high-grade refractories. They should be laid in a mixture of carborundum and clay, as similar in composition as possible to that which the bricks are made. They are used for the side walls, arches, and hearths of oil-fired furnaces and kilns of all kinds, and also muffle furnaces, the hottest zones of blast furnaces, and in furnaces burning pulverised fuel. They should not be used when coal contains much iron.

CHARACTERISTICS OF CARBORUNDUM BRICKS COMPARED WITH OTHER REFRACTORIES

Material.	Specific Heat.	Thermal Conductivity.	Crushing strength in lb. per sq. inch.
Fireclay bricks	0·192	00·034	1·050
Saggars	0·187	00·033	1·340
Magnesite bricks	0·220	0·0071	4·800
Chromite bricks	0·174	0·0067	3·900
Carborundum (1)	0·162	0·0275	12·500
Carborundum (2)	0·180	0·0343	14·700
Silica	0·191	0·0020	2·300

Scratched-face Bricks.—Ancient bricks were often turned out with their sides scratched or scored. No doubt at first this was done with the intention of securing better adhesion with the mortar. But it was soon found that the scoring could be so applied as to give an ornamental value to facing bricks. A good deal of mediæval work, more particularly in Italy, shows excellent examples of this, which was carried to a high pitch of artistry. Then the fashion died out and became quite lost with the greater care shown in puddling the clays and moulding the bricks, especially when mechanical processes were introduced. Now, however, when architects and clients so frequently demand a brick having a distinct texture for the face, there has been a decided revival of the old practice. It is interesting to note that in the United States a scratched-face brick was first introduced over there as the tapestry brick, because of its scored face, seemingly cross hatched with a mason's drag, which gave it the appearance of a woven surface. It has now become very popular in England. Probably this style of treatment is to be preferred to definitely scored patterns. It gives a slightly uneven surface, with a decided texture, enhancing the value of colour, without being too fidgety.

A variation of these are the special facing bricks for rough-casting work (such as the Hold Fast) with a roughened surface to serve as a key for the rough-cast.

Purpose-made Bricks.—Now that the artistic as well as the utilitarian qualities of bricks are again becoming so widely appreciated, it is well to point out that the builder's task can be greatly simplified if he avails himself of the best mechanical products. Much of the costly and difficult work of cutting can be avoided by using the appropriate description of purpose-made bricks. These include splays, bullnoses, plinths, cants, kneelers, squints, and moulded quoins, but above all bricks specially designed for the construction of arches. In ordinary work, and particularly in the case of blind arches built into the walling, the radius is very generally, and quite properly, formed by the minimum of rubbing or axing the bases of the bricks (placed upright) and spacing out at the top with rather more mortar, thus obtaining the fanlike expansion. But with more elaborate work, especially large ornamental arches or those having to sustain heavy loads, much close fitting is required and then considerable cutting has to be undertaken, unless properly designed purpose bricks are carefully selected.

There can be no doubt that such bricks are a source of security in quick walling. In this connection it is interesting to find that the United States Government, in a specification prepared for the Post Office Department buildings, makes the use of such bricks obligatory. Clause 32 (there are altogether 90 clauses in this specification) lays down that for external corners which are not right angles special bricks must be provided for the full height. This would seem to do away with the possibility of splayed corners to the first floor level, with corbel bracket supporting the right-angled upper part, a device often adopted by our old builders and of late occasionally revived to advantage, for instance in courtyards or narrow streets.

Archwork.—Clause 33 of the specification just mentioned requires that all bricks to be laid in curved surfaces of less than 6 inches radius must be special moulded radius bricks that will produce a true surface of revolution. While the next clause says that all bricks for arches shall be specially moulded so that radius lines will be true, the joints to be made of uniform widths and the soffits regular. This, of course, is sound practice, and although it may be somewhat too exacting for average work, it is a policy of true economy of labour and material in heavy work.

Fixing Bricks, either made for coke breeze, or under a patent process, are used as a substitute for wood blocks for inserting where it is required to fasten wood beams or fixtures by means of nails.

Air Bricks, with perforations for ventilation, are made either from Gaults, as already stated, or from terra-cotta.

Veneered Bricks.—In the United States they are rapidly bringing into active use a " veneered " type of facing brick. This is a machine-made brick in which the top face of the bar as it leaves the moulding machine prior to cutting is covered with a thin layer, or veneer, of refractory clay mixed with carbonate of lime.

These mixtures are most carefully prepared, different percentages of lime being added to the clay and formed into trial cases for firing in kilns. In this way, a fusible mixture suitable for the body of the brick is obtained. From 1 to 30 per cent. of lime may be needed, according to circumstances. Colour varies considerably, this usually being secured by adding manganese to obtain a vivid brown, a mixture of manganese and red oxide of iron for " blacks," while manganese in grain produces dark patches on a greenish background. This veneer, being partly vitrified, gives a hard impermeable face, but not necessarily a glazed one.

Sand-lime Bricks.—These are moulded, steam hardened under pressure, and made of fat lime (or hydraulic lime in default) and clean siliceous sand. They are white, cream, or grey (though they can be coloured by oxides), with a texture ranging from that of sandstone to Staffordshire blue bricks, are regular in shape and size, durable, and their crushing strength may reach over 200 tons per square foot. They are more quickly made than kiln-fired bricks and somewhat cheaper. They are suitable for general purposes and are useful as a cheap substitute for glazed bricks in the interior finish of schoolrooms, factories, lavatories, corridors, or courtyards. It is claimed that their regular shape and sharp angles tend to increased rapidity in laying.

Cement-concrete Bricks.—These are made from a mixture of Portland cement and clean, sharp sand, quarry waste, or other suitable aggregate, the mix being moulded semi-dry, and are matured by steam-curing. For sea-water work a proportion of Puzzolanic material is added and for other purposes slag cement is substituted for Portland. They are merely small cement-concrete blocks and so their face may be incrusted in the mould with granite chips or other vitreous aggregate.

Glazed Bricks are used for external and internal work, where light-reflection and cleanliness are essential. (1) Salt-glazed bricks are glazed while in the kilns and are not liable to chip. (2) Half-glazed bricks are glazed after moulding and then fired. These two are usually white, though sometimes cream coloured or brown. (3) Majolica-glazed are clipped into white clay " slips " and cemented into the glaze. They are twice burned and are of different colours. The principal use of glazed bricks is in connection with factories, areas and wells of offices, blocks in hospitals, dairies, fishmongers', schools, swimming baths, railway stations, public lavatories, and work of that kind, and they play an important part in brightening life and aiding sanitation and general welfare.

Hollow or Cavity Bricks.—Apart from air or ventilating bricks, cavity bricks are also made for use in fire-resisting floor and similar construction, as well as for filling screen walls in framed structures. They are now also being used for partitions and general walling purposes, in the latter case usually above the damp-proof course on solid brick foundations. It is claimed that among the advantages secured by this system of manufacture are reduced weight and improved insulation as regards sound, heat, and moisture. The reduction in weight gives greater ease in handling and permits of economy in foundation construction. We may take as a type of this class the Phorpres patent cellular Fletton, which is made to R.I.B.A. standard size, with a saving of about 23 per cent. on the weight of an average Fletton, a very considerable amount on the cube of brickwork. This brick is divided into three cells on its face by two diaphragms across its width. It is, of course, a machine-made brick and has the exactness and smoothness of finish of its type. Whatever opinion may be held as to its value as a facing brick, for panel work in steel-framed building, as in nogging in old half-timbered work, it possesses distinct advantages.

Hollow-brick Blocks.—These may be classed as coarse terra-cotta, being outsize bricks, moulded from brick earths and kiln fired. There are a number on the market, varying greatly in size, shape, and especially construction, though all light in weight for their dimensions. They are machine moulded and divided into cells by diaphragms of brick forming an integral part of the mass. It will be sufficient to give here a few particulars of the outstanding types introduced from time to time. The Frewen building unit is a double-cavity brick block, the sections being oblong and staggered longitudinally and horizontally, the difference of the levels being ⅛ inch, while the top is slightly domed, and the bottom dished or concave. The diaphragm is ¼ inch thick. Full-sized units measure 12 inches long by 9 inches deep and 6 inches wide ; but half units and quoins are also supplied. Little mortar is needed with these units. The Mansfield unit is also a double-cavity block, those with vertical division measuring 12 inches by 9 inches by 9 inches and those with horizontal division of the same length and depth but made in widths of 2½ inches, 4½ inches, and 6 inches. Special fitting blocks are also made. Each unit has a convex moulding along the top and a concave moulding along the bottom, so here again little mortar is required, while alignment is made easy. The Clare "Interloc" unit is normally a double-celled brick, measuring 12 inches by 6 inches by 6 inches, or 12 inches by 9 inches by 6 inches, with an horizontal diaphragm; the top and base have dovetailing mouldings lengthwise. There are also partition blocks, 4½ inches and 3 inches thick, closers and circular-headed floor blocks, 12 inches by 10 inches by 6 inches. It is claimed for these hollow blocks that being of large size, yet light, walling is carried on rapidly and with an appreciable saving of mortar. Most of them being designed for interlocking, thin jointing is the rule. Such blocks under tests have shown up well; in one case the average cracking strain was reached at 450 lb. per square inch (minima 390 lb., maxima 530 lb.) ; crushing strain, average 810 lb. (minima 730 lb., maxima 920 lb.). While in theory these large hollow blocks tend to rapid building, they undoubtedly call for special care in handling, as both diaphragms and interlocking devices may be damaged by rough handling. If labour may be saved in jointing, this would seem to be counterbalanced by the niceties of adjustment, especially in bedding, and it is evident that with these, as with ordinary bricks, vertical joints must be broken, so necessitating the use of half units or closers. Readers should refer to the chapter on Terra-cotta and Glazed Ware, which deals with a similar, if richer, material, though differently handled in building operations.

DEFECTS IN BRICKS

Bricks should be inspected on delivery at the job or yard, all defective ones being rejected. But it is impossible to ensure adequate inspection of each individual brick, so it should be a standing instruction to bricklayers and their labourers to throw out any defectives that come into their hands.

There are a great many possible defects in bricks, some of which can only be detected by testing, such as insufficient resistance to crushing strain, to a great susceptibility to abrasion, and too high an absorptive tendency. There are, however, numerous faults which can be easily recognised at sight or on handling, and these may be passed in review here.

For general purposes, more particularly for house work, a soft brick, which scratches easily and gets the edges rubbed off, and is therefore apt to crumble under pressure or even on exposure to weather, should be rejected. So should those with a high absorptive ratio, which greedily suck up water, often quickly depriving mortar of its necessary moisture. These defects may be due to the use of inferior materials, to insufficient preparation, or to carelessness in firing. An underburnt brick is usually soft ; an overburnt brick, though generally hard, is also either friable or brittle. Both may be cracked or pitted, and these should be thrown out for all but the cheapest kind of garden walling. So should those showing pockets of unburnt clay or nodules of lime, the result of bad grinding or mixing. The presence of gravel or stones is also a serious defect. Bricks showing patches of partial vitrification should be thrown out, because, apart from their being unsightly, this flaw may lead to rapid disintegration, and is, in any case, clear evidence of want of homogeneity, the direct consequence of incomplete mixing or irregular burning.

COLOUR

Colour, apart from its indication of source of origin, is of little moment constructionally for ordinary brickwork, but for domestic and high-class commercial work, increasing attention is given to the matter, both architects and building owners attaching much importance to texture and tint. In most high-class work a facing brick with a broken tint is demanded. This may be obtained from natural clays or from an admixture. Wealden flared reds (graduated from deep dark red to purple) are in this class. Iron in the brick earth gives colours ranging from pale yellow to orange, pink to dark red. Lime and a little iron give whites and creams; large proportions of oxide of iron dark blues to purple, the colour being brought out in firing, so that it is not equally dense throughout the mass. Manganese added to oxide of iron intensifies the blue tint, even to black. Magnesia in combination with iron produces yellow tones. Bluish green is due to alkalies present in bricks burnt at a high temperature.

It is well to remember not to mix different coloured bricks unless approximately of the same absorptive character, otherwise the red of most bricks (certainly when due to iron) will stain the white work after rain.

STANDARD SIZES OF BRICKS

The Royal Institute of British Architects in conjunction with the Institute of Civil Engineers and the Brickmakers' Association have adopted the following for the standard size of pressed or Fletton bricks: 8¾ inches long by 4¼ inches wide and 2⅝ inches thick.

To allow for slight irregularities the Council of the R.I.B.A. recommend that specifications should contain the following conditions:

1. The length of the brick should be double the width plus the thickness of one vertical joint.
2. Brickwork should measure four courses of bricks and four joints to a foot.

Joints ought to be ¼ inch thick with an extra $\frac{1}{16}$ inch, making $\frac{5}{16}$ inch for the bed joints to cover brick irregularities, giving a standard length of 9¼ inches centre to centre of joints. The bricks laid dry should be measured thus:

1. Eight stretchers laid square end and splay end in contact in a straight line to measure 72 inches.
2. Eight headers laid side by side, frog upwards, in a straight line to measure 35 inches.
3. Eight bricks, the first brick frog downwards, and then alternately frog to frog, and back to back, to measure 21½ inches.

A margin of 1 inch is allowed for 1, and ½ inch for 2 and 3. These measurements apply to both hand- and machine-made walling bricks.

While there are obvious advantages in having bricks of a standard size, and of goodly proportions, especially for ordinary and commercial work, much of which is to be cased, where artistic effects are aimed at some deviation from uniformity is regarded as essential. It is particularly felt that the standard brick is too large for the average building, particularly where panelling, string courses, pilasters, friezes, and other embellishments in bricklaying are introduced. A brick smaller in length and height is found to give much better results from a picturesque point of view, having a less hard and commonplace aspect. Small bricks, more nearly approaching those of the Tudor and Jacobean periods, are, therefore, largely made, particularly for facing bricks and glazed work generally. These are not found in Flettons or usually in stocks, but in sand-faced or scratched of broken red tints or mottled colours. Such bricks are nearly always of high quality, though not necessarily of close uniformity. They are light-weight bricks, and, of course, a greater number go to the cubic yard. When ordered in large quantities brickmakers are usually willing to produce bricks to the dimensions required by architect or builder. Such bricks are higher in price that ordinary ones, and the cost of laying is somewhat more, for though light in weight they cover less superficial area, and each brick entails as much care and the use of as much mortar in bedding.

WEIGHT OF BRICKS

Bricks being made from a variety of materials and according to different methods, naturally show a considerable range in weight, quite apart from actual size. The difference is as wide as a little under 5 lb. to rather over 10 lb. per individual brick. The following may be taken as fair averages: Flettons, 5 to 6 lb.; ordinary stock, 6 to 7 lb.; pressed bricks, 7 to 8 lb.; blue Staffordshire; 8 to 9 lb.; rubbers are 9 lb. This should be born in mind, and when necessary an actual weighing test made from the special brick delivered, taking at random ten bricks from a load and dividing the result by ten.

QUANTITIES

One rod of brickwork equals 272 feet super of 1½ brick, or 408 feet super of 1 brick. One rod equals 306 cubic feet, and will contain from 4,200 to 4,500 bricks, and have an average weight of 15 tons. A rod of brickwork will require 2 cubic yards of mortar with ¼-inch joints, and nearly 3 cubic yards with ⅜-inch joints. A cubic foot of brickwork in lime mortar weighs on an average 100 lb.; in cement about 110 lb.

A superficial foot of wall facing will require seven facing bricks.

STRENGTH OF BRICK PIERS

According to Hurst, the weight at which a brick pier, not over twelve times the height of its least thickness, will commence to fracture may be taken on an average as under:

Bricks, hard stocks, best quality, set in Portland	40 bricks per square foot
,, ordinary, well-burnt London stocks, as above	30 ,, ,, ,, ,,
,, hard stocks, Roman cemented sand (one to one), as above	28 ,, ,, ,, ,,
,, hard stocks, lias lime and sand (one to two), as above	24 ,, ,, ,, ,,
,, hard stocks, grey chalk lime and sand (one to two), as above	12 ,, ,, ,, ,,

Later tests give crushing resistance in tons per square foot :

	Stocks.	Gaults.	Leicester reds.	Staffordshire blues.
Individual bricks	84·27	182·20	362·10	701·10
Brickwork, in lime 3 to 4 months old	14·34	21·92	36·74	74·30
Brickwork in cement 3 to 4 months old	14·93	33·68	67·76	87·94

The following are tests carried out by the Building Materials Research Committee of the Building Research Board :

RESULTS OF EXPERIMENTS ON STRENGTH OF THIN WALLS

Description.	Crushing strength of cube.	Age of cube when tested.	Crushing strength of wall 14 feet wide by 8 feet 6 inches high.	Age of wall when tested.	Horizontal pull to break wall 3 feet 6 inches by 8 feet 6 inches high, under vertical load of 1 ton per foot run.	Age of wall when tested under horizontal pull.	Remarks.
	lb. per square inch. 9″ × 9″ × 9″	Days.	lb. per square inch.	Days.	lb.	Days.	
Stock bricks, 3 to 1, cement mortar wall, 4½ inches thick		26	638	24	895*	34	*In this specimen a vertical load of 2 tons per foot run was applied in connection with horizontal pull test.
Stock bricks, 6 to 1, cement mortar	720	26	562	23	791	41	
Fletton bricks, 3 to 1, cement mortar wall, 4½ inches thick	1,530	26	1,040	24	781	39	
Fletton bricks, 6 to 1, cement mortar wall, 4½ inches thick	1,250	26	930	23	705	36	
Fletton bricks, 3 to 1, lime mortar wall, 4½ inches thick	1,050	22	330	24	375	27	
Fletton bricks on edge, 3 to 1, cement mortar wall, 2⅝ inches thick cast in one piece	1,470	29	1,040	23	553	44	

ROYAL INSTITUTE OF BRITISH ARCHITECTS' TESTS

Nature of Brickwork.	Crushing strength, Tons per square foot.
London stocks in lime mortar	12
London stocks in cement mortar	17
Gault bricks in lime mortar	21
Gault bricks in cement mortar	24
Leicester reds in lime mortar	32
Leicester reds in cement mortar	54½
Staffordshire blues in lime mortar	74
Staffordshire blues in cement mortar	77½

UNWIN FOUND GREAT VARIATIONS

For instance, London stocks gave between 84·27 to 181 tons per square foot ; Leicester reds, 150·6 to 337 ; Rugby common, 120 to 190 ; Staffordshire blues, 275 to 650 (pressed, 275) ; Gault, wire cut, 145 to 170 ; glazed, 166 to 174. These may be taken as fair averages for guide to character.

ABSORPTION

After one week, bricks partly immersed, being ¼ inch above water for escape of air :

Vitrified, 1·16 to 1·85 per cent. of own weight.

Good red and close facing bricks and white glazed, 5·31 to 10·24.

Gaults, wire-cut facers and rubbers, 12·95 to 20·50.

As distinct from the above wetting tests, Professor J. W. McBain and Dr. Ferguson of Bristol University (1927) found that red wire cuts, red rubbers, and blue Staffords did not absorb atmospheric moisture, but stocks did to a widely varying degree.

TRANSMISSION OF HEAT

Result of tests by Building Research Board :

Type of Wall.	Coefficient of transmission
4½-inch double-brick wall, 3-inch cavity, without ventilation . .	0·33
4½-inch double-brick wall, 3-inch cavity (ventilated top and bottom)	0·42
4-inch thick hollow brick tile	0·44
9-inch plain, unplastered brick wall (London stock) . . .	0·43
4½-inch brick wall unplastered	0·57

Thus the 4½-inch double-brick wall with 2-inch unventilated cavity offers the greatest resistance to the transmission of heat, so, other things being equal, should provide the warmest house in winter and the coolest in summer.

The same tests showed that the porosity to air of stock bricks was 0·13, and of Fletton 0·17, as compared with compact, non-porous, concrete slabs, which gave an average of 0·0014.

TILES

Brick earth tiles for building purposes are produced in the Fareham and local red types of clay, being much like roofing tiles, but without nibs or pegging holes. They are about the size of bricks in length and breadth, but much thinner, and are used chiefly for arch work, forming caps or string courses; also, placed upright, for crestings to boundary walls (tile creasing). They are also occasionally used for casing walls, though tile hanging with roofing tiles is more common.

Slightly stouter than ordinary tiles are the *creasing bricks*, measuring 9 inches by 4½ inches by 1 inch, and the briquettes, 6 inches by 3 inches by 2 inches.

When using tiles and bricks in combination it is well to see that the dimensions of each are such that the bricks form multiples of the tiles without having to employ undue quantities of mortar for the latter.

Glazed Tiles are also made in various dimensions and colours. A favourite brand of white glazed tiles are made 8 inches square. They are used in place of glazed bricks where either economy is essential or the lining is carried out after the completion of a building. They are, of course, bedded flat.

Faience and encaustic tiles comprise an important group, which may be of a single tint or decorated in many colours, either flat or embossed. They are almost exclusively used for wall tiling, though some varieties are also employed for the paving of halls, etc. There are two main processes of manufacture. In the "dry" process the selected and prepared clay is pressed dry by hydraulic presses. They are then decorated and fired. Under this process there is practically no shrinkage or warping, consequently size and shape are well maintained, and adjustment in bedding is quick and easy. But they do not last so long or weather so well as tiles prepared by the "wet" process, in which the mixed and moistened clay is pressed into the moulds, dried, and fired. In very fine work the tiles are covered with a slip, or engobe, of white clay. In some cases the natural colour of the clay is preserved, when a clear, colourless, glazed tile is used. More generally oxides, or other suitable colouring material, are mixed with the glaze. The glaze is only applied to the face.

Colour decoration may be applied "underglaze" or "overglaze." The former is more durable, the second allows of a much greater and more brilliant range of colours to be used. Raised ornament is embossed in the moulding and pressing. Curved tiles are also made for lining the soffits of arches, coving, etc. They are also usually indented in different kinds of patterns at the back to provide a key.

Another type of tile has the design impressed in the wet material, these depressions being subsequently filled in with differently coloured clay or clays, and then fired. Plain or elaborate patterns, usually of a geometric or conventional character, are obtained in this way.

Hand-painted tiles may bear an individual design, each being complete, or may form part of a general design. This is usually the case with pictorial work. In such cases the tiler is provided with a key plan or sketch to ensure accurate bedding.

Decorated and plain glazed tiles are generally made flat and rectangular. But for special work concave and convex tiles are obtainable, and they are also made in various geometrical patterns, usually for paving, friezes, etc.

Stock sizes are: 6 inches by 6 inches, 4¼ inches by 4¼ inches, 9 inches by 3 inches, 6 inches by 3 inches, 3 inches by 3 inches, 2 inches by 2 inches, 1½ inch by 1½ inch, 1 inch by 1 inch.

Larger and intermediate sizes are also made; also small oblongs for fireplace work, friezes, borders, etc. Plain glazed tiles are also made as stretchers and headers, standard brick sizes, and briquettes.

Further particulars on the manufacture of bricks are given in the Appendix, Vol. III.

CHAPTER III

MORTARS

Materials : Limes—Plaster-of-paris—Medina Cement—Keene's Cement—Fireclay—Pudlo—Puzzolana—Ruvan Cement—Portland Cement—Tests—Setting—Purity—Fineness—Soundness—Aggregates—Sand—Crushed Bricks—Water. Mortars : Cement Mortars—Remixed Cement Mortar—Lime Mortars—Gauged Lime Mortar—Mastics—Purimachos—Concrete.

MORTAR is as important to the bricklayer as are bricks. It serves the purpose of a soft bed, equalising all irregularities in the bricks and filling voids, thus preventing water penetrating the wall, and at the same time provides an adhesive material which cements the whole walling together, giving it solidity, resistance, and a certain measure of impermeability. It therefore follows that care is required in the selection of materials, their mixing, and in the use of the mixed mortars.

Types of Mortar.—There are various types of mortar: lime mortars, cement mortars, gauged mortars, grout (or liquid mortar), mastics and putties (containing lime and mortar). Mortars are composed of a matrix and an aggregate. The matrix consists mainly either of lime, gypsum, natural cement or an artificial cement, such as Portland cement. The aggregate is usually sand, but may also consist of crushed brick, etc.

MATERIALS

Lime is still the chief component of mortars in general, although cement is being more and more largely used in important building operations.

Limes.—Limes are divided into three main classes : non-hydraulic, hydraulic (which have the power of setting under water, and are largely water repelling), and selenitic, usually termed selenetic cement.

Lime is obtained from burning limestone, chalk, etc. Burning is important, because imperfectly burned lime will not slake properly and is liable subsequently to " blow " in the mortar, that is to say, absorb moisture by which it expands and disintegrates the mortar.

Limes are divided into three classes : (1) Pure, Fat, or Rich Lime (known as Chalk Lime in the London district), which should not contain more than 5 per cent. of impurities. (2) Poor or Lean Limes, which often contain from 0 to 20 per cent. of impurities. (3) Hydraulic Limes, which are produced in three degrees of strength, Feebly, Moderately, and Eminently Hydraulic.

Pure, fat, or rich limes are generally used for internal walls, plastering and repair work. They have little strength.

Poor or lean limes, owing to their impurities, are feeble and only used for cheap work.

Dolomite limes contain magnesia and make stronger mortars than either fat or lean limes.

Selenitic limes are prepared by mixing lime with sulphuric acid, or adding about 5 per cent. of calcium sulphite to lime. It is most frequently used in its forms of Patent Selenitic Cement. They are moderately hydraulic.

Hydraulic lime, such as Dorking grey lime, is a moderate hydraulic lime and is used extensively in London and the provinces for the making of mortar. It is very suitable for the purpose and attains a considerable degree of hardness in course of time. Strong hydraulic limes which are sold in bags and ground into a fine powder, when mixed with sand in the proportion of 1 part of lime to 2 or 3 parts of sand, make a very fine mortar. Blue lias lime is an hydraulic lime and one of the best of the natural hydraulic limes. It is especially suitable for work under water or for foundations in damp situations.

Gypsum is seldom used except for plastering and as a component of special cement, etc. For instance, plaster-of-paris is produced by the heating of gypsum in closed vessels to a very high temperature. Gypsum is a soft stone varying in colour from white to brown and is found in Westmorland and Derbyshire and in very large quantities near Paris. The finest powdered grained variety of gypsum is termed alabaster. Plaster-of-paris is used in connection with the fixing of stoves, mantles, and various plug holes. It is very useful in this connection owing to the rapidity of setting and its expanding powers at the time of setting, but should not be used in exposed parts of a building. It is sometimes mixed with lime and also with cement. Plaster-of-paris is mixed with lime to increase the rapidity of setting. Gypsum is also mixed with Portland cement, a small proportion being used in the manufacture to produce a slower setting action in the cement.

Medina Cement is of a light brown colour, and has similar qualities to the Roman cement; it has a greater strength than Roman cement after setting.

Keene's Cement.—This cement is made by recalcining plaster-of-paris (which means reducing the plaster-of-paris to a powder by means of heat), this is then soaked in a solution of alum. This is used for tiling, internal wall decorations, where a slower setting action is required.

Hydrated Lime.—This is a powdered lime which is slaked by the means of steam.

Citric Acid dissolved in clean water will retard the setting action of plaster.

Alum or lime mixed and dissolved in clean water makes plaster set more quickly.

Sirapite is a variety of plaster-of-paris which is made from gypsum found in Derbyshire and impregnated with petroleum. It sets quickly, but should on no account be used on damp walls. It is used extensively for interior wall surfaces; it makes, when finished, a hard, durable, and smooth surface. It is generally used as a finish coat about ⅛ inch in thickness; sometimes a small proportion of lime putty is mixed with it.

Fireclay is used extensively for bedding and joining all classes of fire work, such as the setting for fireplaces, furnaces, boilers, etc. A good fireclay should consist of a large proportion of silica varying from 50 to 80 per cent. and about 20 per cent. to 35 per cent. of alumina. The clay should have a greasy feel when held between the fingers. Fireclay fills the voids between the two surfaces of the bricks. It has very little adhesive power, as it shrinks very much when drying. Sometimes lime is added to increase its cementing power, about 1 per cent. of the bulk being used. When fire work is constructed care should be taken to soak the bricks in water before using them. When the work is completed, the fire or heat should be applied gradually before attaining the maximum heat which is required.

Pudlo is a very useful cement waterproofing powder, but its composition remains a secret. It can be used in the waterproofing of cement mortars, concrete, etc. I have used it on various occasions and found it to be satisfactory in resisting dampness. It is generally used in the proportion of 5 lb. of the Pudlo to every 100 lb. of Portland cement with a proportion of sand with it. For instance, the cement and sand proportions might be 1 part of cement to 3 or 4 parts of sand. The materials should be thoroughly mixed together 3 or 4 times in a dry state and then twice in the wet state to the consistency of a stiff mortar. It is also used for waterproofing drainpipe joints, vertical damp-proof courses, and various other work where dampness occurs, or is likely to occur.

Puzzolana is a volcanic substance found at Puzzula in Italy. It consists of alumina, silica, and small quantities of potash, lime, magnesia, and metal oxides and other mattes. Puzzolana mortar is weaker than cement mortar. It is not used much in England, though sometimes it is used mixed with an hydraulic lime. This produces a much better mortar, and is considerably stronger than the former mortar.

Roman Cement is a natural cement which consists of nodules found in the London clay and shale beds of the Lias formation. These nodules are burnt at a low temperature in the preparation of the cement. It contains about 40 per cent. of clay and weighs about 75 lb. per bushel. The colour is of a rich brown. It is weaker than Portland cement, being only equal to a third of the strength. It sets very quickly, the usual time being about fifteen minutes after it has been mixed. Only a very small portion of sand should be used with it, as this weakens it considerably. It is sometimes used for works under water where a rapid set is required. It is also used for various repair work, etc.

Portland Cement.—It is not proposed here to deal fully with the manufacture of limes and cements, but to explain a few characteristics, tests, and actions which take place when these materials are used.

Portland cement being one of the most useful and valuable materials in relation to the mixing of mortars, the bricklayer should know the various qualities, and tests which should be applied in order to show that the material is of a good quality.

Briefly, Portland cement is produced from a lime product, viz. an artificial mixture of chalk and clay or limestone. These are eventually dried and burnt, and then ground into a fine powder, after passing through various sieves, etc. The finished material is Portland cement. The name Portland cement was given to it on account of its colour, which resembles Portland stone. The colour of the finished cement is a dark bluish grey. This varies from a darker to a lighter shade according to its composition. Good Portland cement contains about 60 per cent. of lime, 20 per cent. to 21 per cent. of silica, and 4 per cent. to 10 per cent. of alumina, and various small quantities of oxides, alkalies, and other organic matters. The various raw materials used in the manufacture will eventually produce various effects in the finished cement when in use, therefore the more perfect the combination of the right materials in the manufacture the better the results will be. For instance, too much lime will eventually produce blowing in the cement. If the cement is overburnt it produces a slow-setting cement ; or if it is underburnt it will produce a quick-setting cement. Again, if there is too much clay in the mixing of the raw materials, it will produce a quick-setting cement and also a cement that will shrink or contract. The finer the cement is ground, the stronger it will be and at the same time the weight per striked bushel will be less. These are two very important points which should be considered when selecting and testing the quality of a cement. When a cement is required that for various purposes it should have a slow setting, gypsum is usually added in small quantities to produce this effect. A cement is said to be slow setting when the final setting time is not less than two hours or more than seven hours. In quick-setting cement the final time of setting should be not less than 10 minutes or more than 30 minutes.

TESTS

Setting tests consist of mixing the cement with a proportion of clean water to a plastic state, and putting it into a mould, called the Vicat mould. This mould is used in conjunction with the Vicat needle, an instrument which by certain movements makes an impression upon the cement in the mould, and so registers the exact setting time of the cement.

The test for soundness is generally carried out by the Le Chatelier method, for which an instrument is used which indicates the soundness of the cement.

Another test is the registration of the tensile strength of the cement. Cement and sand are also tested by this method for tensile strength.

This consists of mixing the cement to the proper consistency, placing it into moulds, and firmly pressing it in. These moulds are placed on non-porous plates until the cement sets. They are kept in a cool place and afterwards immersed in water for a certain period. At the required time these briquettes of cement are taken from the moulds and placed in a machine which pulls them apart, being so constructed that it registers the tensile strength of the cement. A good Portland cement should be of the required standard, and pass the following tests for fineness, specific gravity, tensile strength, setting time, and soundness. The above tests are usually carried out in the laboratory.

I will now give a few simple tests which can be carried out in the ordinary way.

Expansion and Contraction.—This can be carried out by mixing a portion of cement to the consistency of a thick cream, and then placing it into a glass bottle, which should be filled up to the neck, and allowing it time to set. After it has had reasonable time to set, take the bottle and shake it, when it can easily be seen if the cement has contracted, for it will make a slight noise when shaken and move about in the bottle. In this way it can actually be seen to what extent it has contracted or shrunk. If the cement has expanded it will by this time have cracked the bottle. If it has neither contracted nor expanded it will exactly fit the interior of the glass bottle and remain firm.

Purity.—Simple tests can also be made for purity, excess of various materials and adulterations, etc., by taking a small quantity of cement and mixing it with water, which should be clean, to the consistency of thick paste, covering this with muriatic acid, slowly stirring whilst it is being poured on to the cement (muriatic acid is acid obtained from sea salts or brine). Any excess of lime will cause strong effervescence ; the acid will boil and give off a strong fume, until the carbonate of lime has been eliminated. After this, a bright yellow jelly will form on the surface. If there is any colouring matter in the cement, the jelly which forms will not be of a bright uniform yellow colour, but will show a variation of dark and light yellow colour. This indicates that the proper substances and also the proper component proportions have not been adhered to, and that some colouring matter has been used to make up this deficiency.

Good Portland cement will give off a pungent gas, and will only show a slight effervescence when the acid is poured on to it. If the cement has been mixed or adulterated with powdered slag, various colours will be seen, such as yellow and green spots, when the cement is dry. Cements which show an excess of lime, or which have been adulterated with colouring matters, etc., should be rejected. Sand can be tested likewise, but the adulterants in this case will form a sediment and remain at the bottom of the glass. Portland cement has a gritty feeling when tested or rubbed between the fingers. Cement which has been adulterated with furnace slag has no gritty feeling, and the colour after a pat has been made, immersed in water for a considerable time and then broken, has a distinct bluish-green colour, and not the colour of a good Portland cement, which is a bluish grey.

Rate of Setting.—This test can be carried out in a simple manner. Good Portland cement should develop an initial set in not less than thirty minutes and a final set of not less than two hours or more than seven. A portion of the cement for this purpose should be taken from a sack of cement, and the mixer should take this portion from the centre of the sack as near as possible. The cement should then be mixed with clean water, from 17 per cent. to 20 per cent. being required. It should then be made into a small pat, about half an inch in thickness, and laid on a clean piece of plate glass. The initial set usually commences and can be registered roughly when it takes a slight pressure of the thumb to insert the nail into the surface of the cement. The final set takes place when the pat or ball of cement is perfectly hard and no indentations can be made on the surface. If a ball has been made this can be thrown from a height of 5 feet or 6 feet and show no signs of indentation marks on the surface, no cracks of any kind, etc. Of course, these are rough tests used for ordinary purposes, but which should give a general idea of the cement as to its qualities before being used, if there is any doubt about it.

Fineness.—This is a very important and essential quality in the manufacture of a Portland cement. This test must be carried out by an expert. I will give an example as to the importance of the cement being ground very fine. Often we come across practical work in which the cement which is used is inclined to expand, or blow as it is sometimes termed. This expansion takes place after setting and is caused by coarse particles which contain free lime being in the cement. These particles have very little adhesive power, absorb moisture, and tend to separate.

Soundness.—Boiling is a very severe test which proves the soundness of a good Portland cement. A circular pat of cement is usually made of a certain size, usually ½ inch in thickness and 2 inches or 3 inches in diameter. This is placed on a piece of plate glass and is kept in moist air for twenty-four hours, and then completely immersed in water. This water is slowly raised to boiling-point and kept at this temperature for three or four hours. Under this test a bad cement will turn into a soft mass like cream, or one which is defective in some quality or other will crack or twist. A good cement will retain its qualities and form under this test. On important work the test for soundness should undoubtedly be carried out by the expert, but for ordinary purposes a rough test can be carried out if care is observed.

Aggregates.—Aggregates for mortars usually consist of sand, although crushed bricks and other materials are sometimes used. They should be clean, free from dust, soil, and organic matters, and must not contain salt. Salt causes effervescence and dampness in the mortar, and prevents the cement and lime used in the mortars from adhering to the particles of sand.

Sand should always be clean. Loam can be detected sometimes by the naked eye and also by taking a handful of sand and rubbing it together ; the loam will be detected by the touch, the sand being sharp and the loam rather of a soft sticky nature. Sand is sometimes examined under a microscope to see whether the grains are of a sharp angular shape or rounded. In sea sand and river sand the grains are of a round shape on account of the continual movement of one grain against the other, while a good pit sand possesses grains which are of a sharp angular shape. Sand is sometimes washed through a sieve to eliminate the loam and other matters found in it. Being very often found mixed with stones or gravel, it is sifted or screened. The wires in the sieves or screens are spaced according to the fineness of the sand required. The frame is usually fixed at an inclined angle with a prop placed at the back of it to keep it in a firm position. The mortar man has a large heap of sand deposited to be sifted, in front of this he places his screen, and fixes it in position, he then shovels up the unsifted sand and throws it against the screen. This being in an inclined position, the surplus stones from the sand roll down the face of it slowly and form a heap, the fine sand passes through the screen and forms another heap and is removed from time to time when ready for use. The stones and rough portion of the sand is generally used for concrete.

Quicksand is sand which is easily distinguished by the particles, which are very small and round, in some cases the sand is as fine as a powder. These small particles are worn round by the action of water. This sand should not be used for mortar. The quicksand, if made into mortar in combination with another material, has the tendency to settle to the bottom, leaving the matrix in the topmost position. The mortar man has to be continually mixing it, in order to combine the two together.

Crushed bricks form an excellent aggregate. Mr. L. E. Walker cites the case of a speculative builder who put up a large block of flats on a plot partly occupied by small houses, which he pulled down. The bricks were crushed on the job, and were mixed with the lime (no sand being used) in the mortar mill. The proportion of lime was below the average, yet the mortar proved quite satisfactory. Indeed, when part of the brickwork had to be cut away, it was found that the mortar had developed amazing strength within a month or two.

A useful mixture is 1 part lime, 2 parts crushed brick, 1 part fine sand ; next dry and gauge in usual way. But, as stated, the sand is not absolutely necessary.

Water.—Water used in mixing mortar must be clean, free from clay, soil, salt, or organic matter.

MORTARS

Mortars vary according to the purpose for which they are required. In all cases accuracy must be observed in proportioning the various component parts, and great care taken in the mixing. As a rule not more mortar should be made than can be quickly used. This is of particular importance where cement mortars are concerned, as in these initial set begins fairly soon, and knocking up, unless the cement is slow setting and contains a certain admixture of hydrated lime, weakens the adhesive powers and the strength.

When lime mortars are used in large quantities it is always advisable to slake the lime on or near the job. For this purpose a pit is dug and boarded, into which quick, or lump lime, broken into convenient size, is tipped, and clean water run in. A ton of lime will require 75 gallons of water. It is stirred vigorously to ensure the breaking up of the lumps and thorough slaking. Great heat and volumes of steam will be evolved during the process. The lime is only fit for use when all the heat has been given off. Good lime (lime putty as it is termed in this state) should be smooth and "fatty." If lumps are allowed to be unbroken, or the slaking otherwise imperfectly carried out, the mortar will be more or less hygroscopic and liable to "blow." When once slaked it should be kept protected from dust and rain.

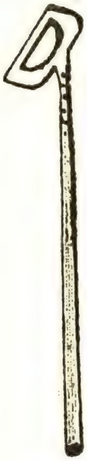


FIG. 1.

Cement must be kept in a covered cool place. But cement straight from the factory is often hot and may require to be removed from its bags and placed in a thinnish layer on boards, being occasionally moved with the spade to ensure aeration and cooling. Recent experiments have proved that—"Cement aerated for long periods gives lower mechanical strength than one aerated for a comparatively short time. It also requires more water to render it plastic and takes longer to mix."

Mortars can be mixed by hand or in a mill. By hand a suitable position should first be selected to place the materials upon. For this purpose a banker is usually laid upon the ground. This consists of a number of scaffold boards, about twelve in number and about 12 feet in length. Four stakes are driven in the ground. This keeps the boards in position and also keeps them close at the joints of the boards, which stop as much water as possible from oozing through the joints. Sand is placed on the banker and a large ring made. The lump lime should then be placed into the middle of the ring of sand, and the pieces of lime broken as small as possible. Sufficient water should then be put on the lime, using a watering-can or a hose with rose attached. The lime should then be covered with sand and the whole allowed to stand from twenty to twenty-four hours. It can then be mixed together with the shovel or larry (Fig. 1) into a paste form ready for use. All the unslaked lumps should be taken from the bed of material and should not be used.

The mortar mill, or mortar pan, is a revolving iron pan with mixing paddles or arms into which the lime or cement, sand or crushed brick, are placed for mixing. The mill is first revolved with the materials in a dry state, water being added gradually. A mill ensures thorough mixing and is more economical than hand labour when large quantities are involved. Large mills are driven by power, small ones by hand, but even with the latter there is a saving of time and labour.

When mixing large quantities of either cement or lime mortar it is best to have various gauges or boxes for the purpose These boxes are made of strong 1-inch boarding with two handles at each end so as to enable two men to lift them; these are made in different sizes, such as the cubic yard box, which would measure 4 feet 6 inches in length, 3 feet in width, and 2 feet in depth. The half cubic yard box, which would measure 3 feet in length, 3 feet in width, and 1 foot 6 inches in depth, and also the quarter cubic yard box, which would measure 2 feet 6 inches in length, 2 feet 6 inches in width, and 1 foot 1 inch in depth. The first equals 27 feet cube, the second 13½ feet cube, and the third 6¾ feet cube.

Cement Mortars.—The proportions of a good cement mortar will depend on the nature of the various constructions for which it is required. A good composition for heavy building foundations, or warehouse and factory walls, would be one part of Portland cement to three or four parts of sand. For foundations which are exposed to dampness a smaller proportion of sand should be used to enable the mortar to set more quickly. In this case the proportions should be one part of Portland cement to two or three of sand.

In hand mixing sand is placed on the banker, and the proportion of cement to be used is placed upon it. The whole cement and sand should be thoroughly turned over with the shovel at least twice in the dry state, to make sure that the material is mixed properly; sufficient water should then be added, usually about 15 to 18 per cent. This should be poured from a watering-can with a rose attached; the material should then be completely turned over twice at least in the wet state. The water used for the purpose should be clean. The material should then be ready for use.

From recent experiments at the Building Research Station it appears that up to a certain period of mixing the plasticity increases for a definite percentage of mixing water, but with longer periods of mixing the paste stiffens, probably partly due to chemical action taking place. The wetter mixes apparently do not require as much washing as the dry mixes to bring them to the same consistence. The time required to reach the point of maximum plasticity varies for the percentage of water tried from three to five minutes. On either side of this range the paste stiffens.

It was also found that the percentage of water required to produce the maximum strength varied from 20·4 to 23·0 for Portland cement, from 24·0 to 32·0 for slag cement, and from 20·8 to 21·6 for high alumina cements.

Other points determined was that finely ground cement, having a larger surface area than a coarser one, needs more water to bring it to a certain plastic condition when mixed with water. Also that the percentage of mixing water producing a paste with the minimum mortar voids gives the strongest set mortar.

The influence of temperature on cement mortars is considerable, but no definite rule can be established as the behaviour of Portland and other cements varies largely with different brands. Almost invariably the hardening time lengthens with the fall of temperature, though in the case of one foreign cement the shorter time of setting was reached with the lower temperature. Generally tests carried out at the Building Research Station showed that a higher strength was attained at 5 degrees C. than at 18 degrees C. when mixing; setting and curing all took place at these temperatures. But the report states that—

" Temperature higher than the normal may affect the strength of a cement mortar or concrete by hastening the chemical and physical actions which take place during the setting and hardening processes. Low temperatures, on the other hand, may retard these actions. At first sight it would seem that, when setting and curing occur at the higher temperatures, higher strengths should result and similarly lower strengths should obtain at the lower temperatures. The effects are, however, rather complicated. In the first place, if the setting operations take place rapidly, i.e. at higher temperatures, then there is the more likelihood of internal stresses being induced. If the setting occurs at a lower temperature the action is slower, and the internal stresses are probably not so severe, the material having had more opportunity of adjusting itself. Then, again, if the specimens are air cured, the variations in the moisture content may cause great discrepancies, and the induced shrinkage stresses may be severe. The initial stresses and the shrinkage or drying-out stresses, therefore, both tend to be greater at the higher temperatures and to counteract to some extent the increased strength to be expected from the increased activity of the chemical reactions. It is to be anticipated, therefore, that the temperature effect upon the strength of mortar or concrete will vary widely under different circumstances. Different cements react very differently to temperature conditions, as show the preceding notes on setting time, and there are many other variable factors such as:

" 1. The initial temperatures of the cement, aggregate, and water.

" 2. The proportions of the mix, the nature of the aggregate and the amount of water used in mixing, etc.

" 3. The air temperatures during mixing and placing.

" 4. The bulk of the mixture and of the specimens affecting the rate of cooling or heating.

" 5. The temperatures of curing.

" 6. The conditions of curing, e.g. air humidity, facilities for evaporation, etc.

" If the mortar or concrete is subjected to temperatures below 0 degrees C., further complicated conditions are introduced. Obviously concrete cannot be satisfactorily mixed when the materials are already frozen. In practice the materials are warmed from some artificial source and mixed before being subjected to temperatures below 0 degrees C. The action of the concrete will therefore depend upon the actual temperature of the concrete during mixing, the temperature of the surroundings, and very largely upon the bulk of the concrete and the nature of any protection afforded, i.e. straw, sacking, etc. Mortars in thin layers or small cubes or cylinders will lose heat much more quickly than large masses of concrete, and the action of frost will be more pronounced. Then, again, heat is evolved during setting, and though the amount is not as large with Portland as with aluminous cements, its influence is probably not negligible. The richness of the mixture, the nature of the aggregate, and the value of the water content will probably all exert some influence upon the behaviour of the concrete under low temperature curing conditions. Most of the experimental work that has been published shows that a considerable amount of hardening takes place when Portland cement concrete is cured at temperatures below 0 degrees C., though several authorities state that no hardening takes place below this temperature.

"Laboratory test specimens are necessarily small in bulk, and it is possible that the result may be misleading in some cases, particularly with aluminous cement concretes. The heat evolved during the setting and hardening processes is considerable with aluminous cements, and the imprisonment of this heat within large blocks, such as are sometimes used in practice, may account for failure to set, as is mentioned later.

"To summarise, special attention may be drawn to the facts that—

"(1) Low temperatures generally seriously retard the setting and hardening of Portland cements; but as the extent varies with circumstances and with the cement, the special advantages of a rapid hardening cement may be retained or they may be lost at low temperatures, and the particular cement should be tested under similar conditions to those likely to hold in its practical use.

"(2) Both Portland and aluminous cement work may be seriously damaged by frost and be unable to recover fully on thawing.

"(3) Aluminous cement bulk work may be affected by high temperature."

Remixed Cement Mortar.—A cement mortar which has been mixed and acquired its initial set, that is, the first set, and then remixed thoroughly, attains the same strength after a long period as the cement mortar which is used at the first initial set. The second mixing must be thorough as its strength depends upon this. The cement mortar is much slower in setting after the second mix, it is weaker than the cement mortar used at the first initial set, up to a certain period (some authorities state that the time is about 6 months); after that time the cement mortar of the second initial set is as strong as the cement mortar of the first initial work.

Lime Mortars.—The lime or matrix in lime mortar depends upon the purpose for which the mortar is required for ordinary building purposes. A greystone lime from Maidstone or Dorking would be suitable. A pure or fat lime should only be used for work that is of a temporary nature. The blue lias lime can be used for good-class building work and in damp situations, such as footings and underground cellars, etc. The Dorking and Maidstone limes are feebly hydraulic limes, and limes like the Halkin Mountain lime are eminently hydraulic. Ground lime is now frequently used in various parts of the country; it is very useful and can be used almost immediately. The proportions which would be required for ordinary building purposes are 1 part of stone lime to 3 parts of sand.

In good-class building work the proportions should be 1 part of selenitic lime to 4 parts of sand.

Piers and walls required to carry weight, 1 part of lias lime to 2 to 3 parts of sand.

When using lump lime about one and a half to two gallons to every bushel of lump lime. The amount of water required varies considerably in relation to the nature of the ingredients used.

Ground lime should be used in the proportion of 1 part of lime to 3 parts of sand. This should be made by hand. The sand should be placed on the banker, the ground lime should then be placed upon this. These two materials should then be thoroughly mixed by turning over with the shovel, the whole of it at least twice; it should then be passed in the dry state through a sieve, or a riddle as it is sometimes called. The materials should be left for a few days, when they can be taken and mixed with water as required for use. This fine material is sometimes used for internal pointing, etc.

Lumpy lime and sand is also passed through a sieve in the dry state when required for good work.

When lime mortar is mixed in the mortar mill, where large quantities are regularly required for general purposes, the proportions are generally 1 part of lime to 3 or 4 parts of sand. Good clean old bricks, as already mentioned, are also used for the aggregate. They should be well crushed. All materials should be clean.

When lump lime is used it should be slaked first and poured into the mortar mill in a semi-liquid state in the proper proportions to be mixed with the aggregate, the water being added as the materials progress towards their proper consistency.

Liquid mortar, which is generally known as grout, is used for grouting in the interior of walls, and for joints in floor tiles, etc. This is made with various materials: neat Portland cement, also neat Portland cement with a small proportion of sand, and also grout lime mortar.

Purimachos is a cement sometimes used by the bricklayer in repairing and jointing firebricks in connection with furnace repairs, etc. It is unquestionably a fire-resisting material. It is sold in tins, is yellow and has the consistency of a thick cream. If in too stiff a state it can be softened by adding water to it.

Lime mortar should never be used in very frosty weather; if the lime mortar after having been placed in position on the wall either as a bed or cross joint is frozen and then thaws it will lose its strength. Sugar is added in the making of lime mortar in India, and greatly adds to its strength. It is said to retard the setting action of the cement mortar, which enables the chemical changes to take place more perfectly; if used in excess it renders the cement useless. It should never be used in damp situations or construction under water, because the sugar is soluble in water. About 1½ to 2 per cent. of sugar is sufficient to add, and should be used in a dry climate. It has been used in India for years.

Gauged Lime Mortar.—This consists of 1 part of lime, 3 parts of sand, and small addition of neat Portland cement to give the mortar quicker setting power. Another method is to add 1 part of Portland cement to 6 parts of good lime mortar; or if to be used in very cold weather, 1 part of Portland cement to 4 parts of good lime cement. This will not be damaged by slight frost. With these mixtures will be no efflorescence.

Composite mortars of the above description are also coming more into favour, as besides being stronger than lime mortars they are said not to be so much affected by vibrations from modern traffic.

Mastics.—These are compositions in which lime and cement are mixed with litharge and linseed oil. They are used for applying to external walls, etc., where exposed to damp, and being plastic and strongly adhesive are also used for uniting brick to metal and other special work.

An ordinary mixture is composed of ground limestone or cement about 5 parts, sand 5 parts, red lead 1 part, and sufficient boiled linseed oil to make a plastic mass.

London mastic is made with 20 parts powdered stone, 5 parts silver sand, 3 parts litharge. Mix and dry the materials. Keep covered until required, then gauge with equal proportions of raw and boiled linseed oil. Beat up thoroughly.

Bricklayers' mastic is made with 20 parts of fine sand, 2 parts of litharge, 1 part quicklime, and sufficient linseed oil to make a paste. It needs very careful mixing.

Scotch mastic requires 14 parts of powdered sandstone, 3 parts of whiting, 1 part of litharge, which must be mixed on a hot plate to dry. It is made into a paste with linseed oil (2 parts raw to 1 of boiled).

A good general-purpose mastic is made with 20 parts of slaked lime, 12 parts of fine sand, 1 part of litharge, and 3 parts of linseed oil.

Sugar in Mortars.—Brown sugar or molasses has been added to mortars both as a means to strengthen them and to enable them to withstand frost. The cost, however, is prohibitive for ordinary work. As a rule 2 per cent. by weight is added to the lime and sand. Hot limes destroy the effect. A useful mixture is said to be: quarter of a pound of brown sugar dissolved in hot water, used for gauging 1 cubic foot of coarse stuff or ordinary mortar.

For cement 1 to 2 per cent. of sugar is melted in the gauging water.

CONCRETE

Concrete is a composition, formed of various materials, which after mixing by the bricklayer forms into an artificial stone. It is used for filling hollow brick blocks and terra-cotta (though this practice is not now recommended), as a walling material between brick casing or veneering, and as a foundation for floorings.

The materials required for this composition consist mainly of two parts, the aggregate and the matrix. The aggregate consists of the hard mixture materials such as broken bricks, or broken stone, coke breeze, limestone, gravel, flint, sand, etc. The matrix consists of the active and cementing materials such as cement and lime. Water also forms another active agent in combination with the matrix.

The aggregates which are used in forming the concrete are divided into two classes: natural and artificial. The natural aggregates consist of materials which are excavated from the earth in their natural form, such as limestone, chalk, gravel, flint, shingle, granite, etc. Artificial aggregates consist of materials which have been artificially treated, such as coke breeze, furnace slag, broken concrete, burnt clay, broken bricks, etc.

The making of a good strong concrete depends, firstly, upon the quality and the nature of the aggregate and matrix; this also includes clean water, which should always be used in the mixing of concrete. Secondly, the proper proportions of the materials to be used. Thirdly, the correct mixing of the materials. All aggregates which are used in the composition of concrete should be clean and free from loam, earthy or vegetable matter. The aggregate should also be of the proper specified size, and uniform throughout. Very fine material in the aggregate should be eliminated. The matrix should be of a good standard specification, cement or a lime from a reputable firm of manufacturers. The materials to be used should be measured to obtain the exact proportions. This should be done in gauge boxes especially made for the purpose, which enable the mixer to obtain the proper gauge at each mixing.

The mixing is also very important. This is sometimes done by hand and sometimes by machine. There is no doubt that the concrete which is mixed by the machine is more thoroughly combined together than that which is mixed by hand.

Foundations which require great strength should be composed of a Portland cement concrete, the proportions of which should be 1 part of Portland cement, 1 part of sand, and 3 to 4 parts of broken brick or ballast. Foundations which are required for work of a temporary character can be composed of 1 part of lime, either a lias or a ground stone lime, 1 part of sand, and 4 to 5 parts of broken brick (this should be clean and should not contain any old mortar or plaster).

In all cases, clean water should be added in the mixing of the materials. The mixing should be performed on a level close-boarded platform to save the finer materials from being wasted and finding their way through the cracks or openings between the boards. If mixed by hand the materials should be thoroughly turned over and mixed dry with the shovel at least twice. Clean water should then be added and the materials again mixed in the wet state to the proper consistency at least twice, making sure that all the particles of the aggregates are covered with the matrix.

All cement concretes should be used directly after they have been mixed. Lime concrete should stand for a period after being mixed, this enables the particles of lime to be all thoroughly slaked before using. Cement and lime concretes used for foundations of any kind should not be built upon for at least a week after being placed in the trenches or foundations.

A good aggregate for floors and foundations is clean broken brick, which should pass through a ¾-inch sieve. All concrete work done in severe frosty weather should be protected with boards or sacks; sometimes hot water is used in the mixing.

When concrete is mixed in severe cold weather, the frost expands the materials which are used, and the concrete loses a lot of its adhesive or cementing power.

Concrete work done in extremely hot weather should be protected by wet sacking and the trenches or foundations should be kept well watered and damp; especially when putting one portion of concrete against the other, the two faces of the concrete should be well watered to obtain the maximum amount of adhesive or cementing power between the two bodies. The hot weather also evaporates part of the water from the concrete and therefore takes part of the water which is necessary for the proper crystallisation of the materials. I have myself spread a layer of sand about 2 inches thick over the concrete directly it has been placed in the foundations and trenches in severe frosty weather, and found this method quite effectual in preventing the concrete from freezing. Concrete made with broken brick aggregate, about 3-inch gauge, seems to stand a greater crushing weight per foot super than concrete made with a ballast aggregate.

Portland cement mixed with a broken brick aggregate, and made in the proportions of 1 part of cement to 6 of aggregate, or 5 parts of broken brick and 1 part of sand, will stand a crushing weight of about 20 tons, whilst a similar cement concrete composed of 1 part of Portland cement and 6 parts aggregate, which is in this case 6 parts of ballast, will stand a crushing weight of about 14 tons; this is, of course, after a period of thirty days. After a longer period the crushing weight will greatly increase. In a lime concrete which has been made for a period of twelve to fifteen months, and mixed in the proportion of 1 part of matrix to 6 parts of aggregate, the matrix made of grey lime or blue lias lime will have a higher crushing strength if the aggregate is brick instead of ballast. Again in the case of the broken brick aggregate used in conjunction with the lime, it has a stronger crushing weight than the lime which is mixed with the ballast, and varies from 10 tons to 30 tons per foot super, varying also with the class of lime used for the purpose, blue lias lime being stronger than the grey lime.

CHAPTER IV

TOOLS AND APPLIANCES

Trowels: Brick Trowels; Pointing Trowels; Joint Trowels; Cross-joint Trowel or Dotter; Gauging Trowel—Plumb Rule, Line and Bob—Two-Foot Rule—The Hawk—The Hod—Pointing Rule—Frenchman—The Jointer—The Square—Club Hammer—Steel Chisel—Brick Hammer—Bolster—Spirit Level—Straight Edge—Pins and Lines—Scutch—Scutch Hammer—Cutting Blocks—Bevel Gauges—Brick Cleaners—Plain Square—Zax—The Dog—Slater's Hammer—Slate Gauge—Slate Ripper—Canadian and American Variations.

BRICKLAYERS' tools and appliances are neither numerous nor very complicated, but they are of great importance in securing good work. Consequently, great care should be taken when purchasing a set of tools, only those of sound quality being selected. As a rule, it will be found that the cheap ones are the dearest in the long run. A good brick trowel, made by a reputable firm, will last the bricklayer for many years, even when in steady daily use. And this applies equally to all other tools.

Another point is, the longer you use a really good tool, the more handy it will become. One has, in fact, to use a trade expression, to "break in" a tool before one becomes absolutely at home with it, so that it becomes almost like an extension to the hand. It is a question of weight and temper, so that time is required before perfect familiarity with the behaviour of a tool is acquired. Thus it is that every bricklayer should have his own tools, for he will feel a certain amount of awkwardness when handling someone else's or taking to new ones. No doubt the handling is the thing, but good tools play a big part in the results.

I am emphasising these points about the selection and handling of the various tools, in order to show how important it is in qualifying to become an efficient craftsman that one should start on a proper and sound basis.

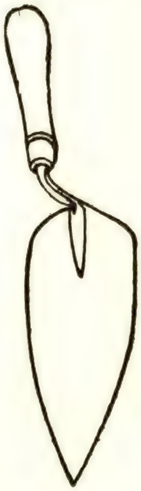


FIG. 2.

I will now describe the various tools and the proper method in which they should be used to attain these essential qualities. In this chapter, I will try to point out step by step the various points to be used in handling the different tools.

The Brick Trowel.—Fig. 2.—This tool is used by the bricklayer for taking the mortar off a mortar board, laying it upon the wall, and spreading it in a uniform bed for the bricks to be laid upon. It is also used for cutting bricks into various lengths. It is a very important tool, and is practically in constant use day after day. The proper use of this tool can only be gained by constant practice, as you will notice if you watch a bricklayer at work. I am giving this information to those about to start learning bricklaying. The brick trowel is held in the right hand, and is worked by the forearm and the wrist, when spreading the mortar, the wrist being used freely and the forearm attaining a forward and backward movement in doing so. The photograph on Plate opposite shows how the bricklayer should hold a brick when laying it on a bed of mortar, and also gives the correct method of holding the brick trowel.

There is also a knack in judging the correct amount of mortar which should be laid on for each course, just sufficient for the bricklayer to lay or press the brick firmly into position without striking it several times, as sometimes is done when too much mortar is placed for the bed.

By constant practice, the bricklayer is able to place the brick almost immediately into its correct position on the wall. When the brick has been laid on its bed, there is usually a small surplus of the bed which protrudes from the face of the brick. This is taken off by the brick trowel by holding the blade at right angles with the face of the brick and pushing it in a forward movement. This again is done by the wrist.

Having explained the movements required in laying and bedding the brick and spreading the mortar, we will now name the several parts of the trowel. It comprises a wooden handle with a steel ferule on the trowel end of the handle about 1 inch in diameter and 4 inches long, with a long diamond-shaped blade attached. This is attached to the handle by a neck or shank which runs into the centre of the handle about 2½ inches. The blade is made of steel, about $\frac{1}{16}$ inch in thickness.

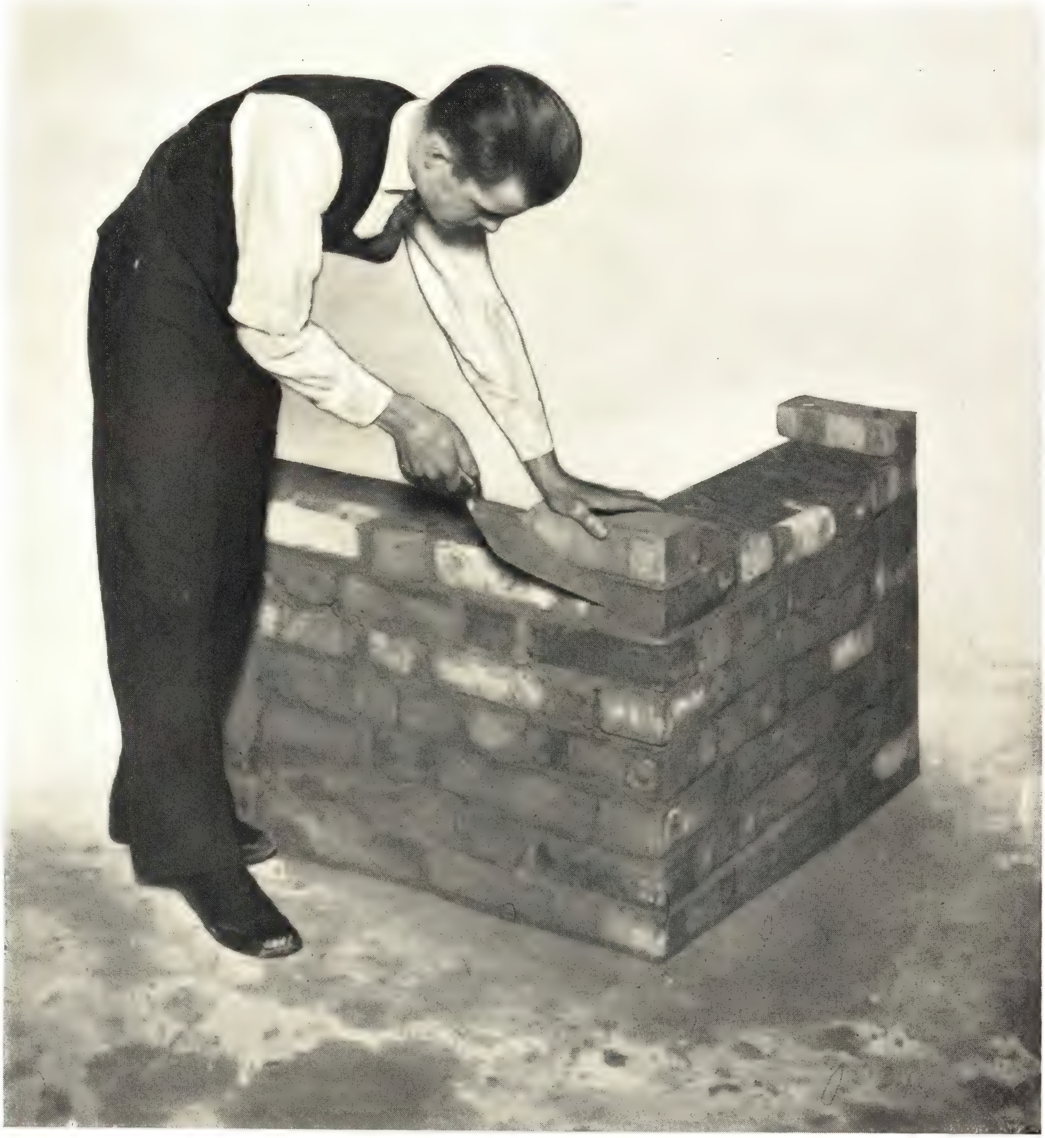
There are various sizes in brick trowels, from the largest, which is about 14 inches in length measuring the blade only, down to the smaller sizes, which are from 8 inches to 10 inches. The large trowel is generally used for heavy and rough brickwork, such as large factory walls, foundations of great widths and footings. These trowels hold a large amount of material, and quite a number of bricks can be laid with one good trowelful. The work executed with these large trowels is not so neat as face work or glazed brickwork. The smaller trowel, such as a 10-inch, is generally used for the more delicate work—for instance, for glazed work when only a small amount of material is needed at one time, just sufficient to lay one brick or two bricks at the most. The small trowel is much better to handle on work of this kind, where neatness and correctness of position are absolutely required.

The blade is of kite shape, almost triangular, but with long point. General jobbing trowels are commonly made in sizes ranging from 8 inches to 10 inches, and are fairly stout. Fine-work trowels may be obtained in sizes running from 10 inches, 11 inches, 12 inches, to 13 inches. They are rather more flexible, being of thinner metal.

PLATE

PLACING QUOIN BRICKS IN A SQUARE ANGLED WALL WITH STOPPED ENDS

Corner of a 9-inch brick wall, with two stopped ends, built with Fletton bricks in Flemish bond. The operative is shown standing in the correct position laying a quoin brick. With his left side to the face of the wall, holding the brick in his left hand, the thumb placed against the face about the centre, the palm of his hand on the frog and his fingers on the back face, he presses it firmly down. The thumb is placed against the front face of the brick about the centre ; he then presses it down firmly into its correct position. The trowel is held in his right hand, his fingers and palm placed against the handle and the thumb on the top of the ferrule, he prepares to remove the surplus mortar from the horizontal base joint. This he does by holding the blade of the trowel at right angles to the brickwork, level with the joint, and pushing it forward, thus finishing the joint on the face of the brickwork to correspond with those below.



PLACING QUOIN BRICKS IN A SQUARE ANGLED WALL WITH STOPPED ENDS.

A separate class are the pointing trowels, used for pointing work, that is, the filling in and striking of joints on wall faces of old and new brickwork. These are medium-sized tools, made in sizes ranging from 2 inches, 3 inches, 5 inches, 5½ inches, 6 inches, 6½ inches, 7 inches, and 8 inches. Another type is the large or bed joint trowel, with blade from 6 inches to 8 inches long. At the extreme is the cross-joint trowel or dotter, Fig. 3, with a blade of 2 inches to 3 inches long. They should be light and flexible, wrist play being important in their manipulation.

Then there is the gauging trowel, with high shoulders and rounded end, made in six sizes, from 6 inches to 10 inches long.

Plumb Rule, Line and Lead Bob.—Fig. 3.—This is a very important appliance. It is used in conjunction with the brick trowel. After the bricklayer has laid a few bricks at the corner of the wall with his trowel, he uses the plumb rule to check the face, so as to ensure the bricks being in a vertical position. This appliance usually consists of a piece of seasoned pine wood about 4 inches wide and from 5 feet to 6 feet in length. The thickness of these laths varies from ¼ inch to ½ inch. A deep line is made in the centre of the rule on the face with a carpenter's gauge. This should be exactly in the centre, parallel to each side edge. There should be an egg-shaped hole about 3 inches long, about 4 inches up from the bottom of the rule. An egg-shaped piece of lead, called the bob, is attached to the line, which is also attached to the top of the rule by running it through a saw cut at the top of rule. The lead bob then swings like a pendulum into the hole made for it at the bottom of the rule. This hole should be ⅛ inch larger than the lead bob, to allow it to swing freely into it.

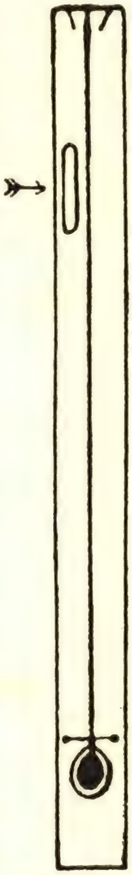


FIG. 3.

When plumbing work, the correct method is to hold the rule against the brickwork closely at right angles, leaning it slightly forward to allow the bob to swing. To prevent the bob from swinging from the rule too widely, two holes are bored with a bradawl each side of the bob hole, and a piece of wire put through, attached from one to the other. These holes are generally 1 inch above the lead bob. This wire, which is curved, stands out about 2 inches from the face of the rule and checks the swing of the line and bob. The line should swing exactly at right angles to the rule, and touch the centre line each time. If this is attained it shows that the wall is in a perpendicular position, or exactly upright. If the bob line swings outside the centre line on the rule away from the wall, it denotes that the wall overhangs, or in other words, the wall is out of perpendicular as shown by the fact that the lead bob is to the right of the rule line and not swinging to the centre line of the rule at right angles. If the bob line swings to the left of the rule and towards the wall, or between the rule line and the wall, the position of the wall is then said to be battering or inclining inwards from the vertical or perpendicular position.

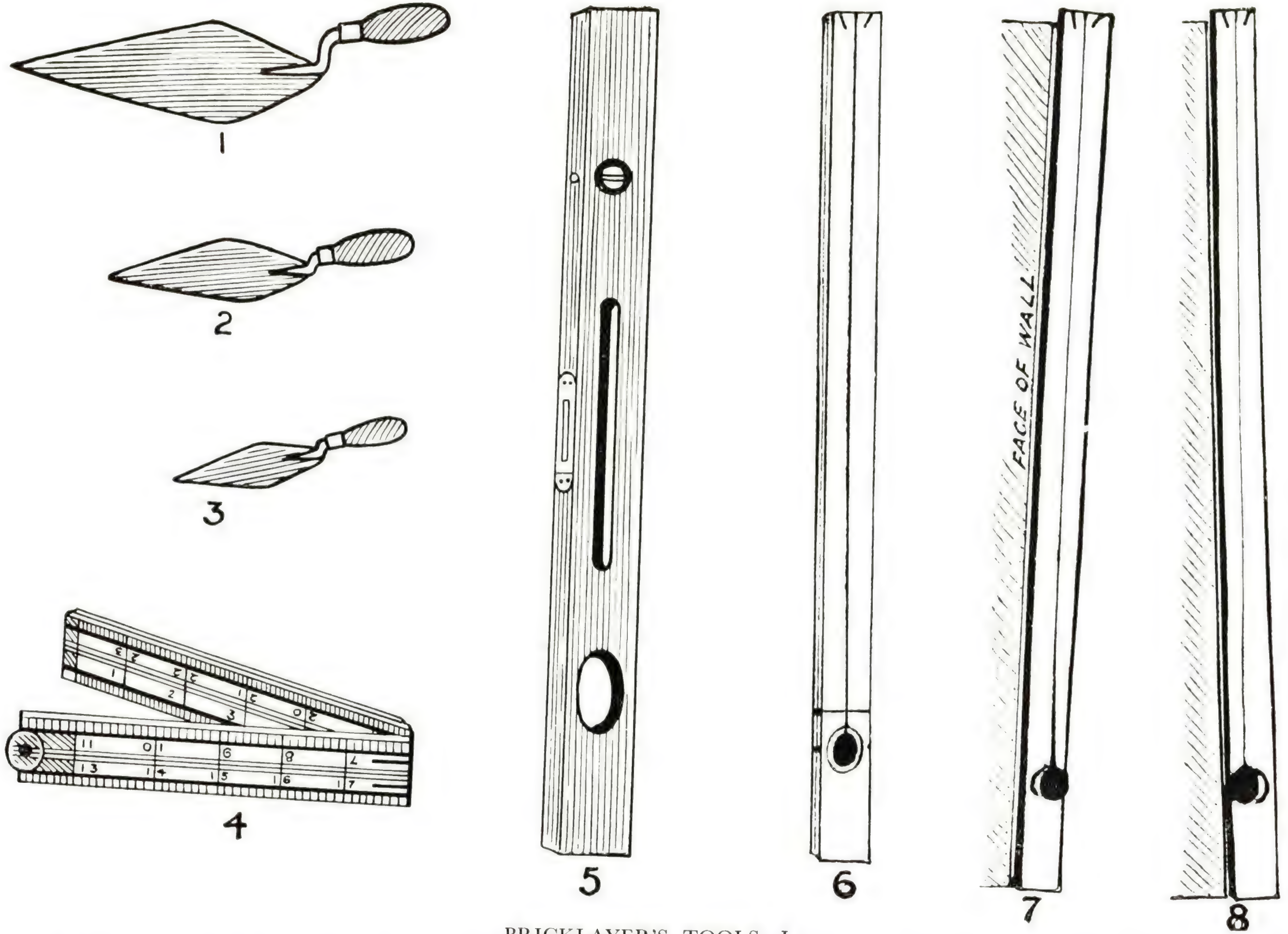
Of course, there are tricks in every trade. I have seen bricklayers swing the bob line to the centre rule line from battering and overhanging positions, but this is most decidedly wrong. The rule should be at right angles to the wall, and the bob line should swing to the rule line at right angles, not at obtuse and acute angles. I have also noticed bricklayers from time to time, when they have the least suspicion that the wall is out of an upright or perpendicular position, to use the thumb of the left hand against the bob line, so as to manipulate the swing of the bob against the rule line. This is sometimes done when the foreman comes round to check the work. Luckily such tricks do not always "come off." Of course these are wrong methods, and should never be allowed.

Another form has both the plumb rule and level combined. These are generally made in a variety of woods, oak, pine, mahogany, etc. They are about 3 feet in length, 4 inches in width, and vary in thickness, the average being about 1 inch. These are made with the egg-shaped hole for receiving the lead bob with line attached, which hangs from saw cuts as shown. They also have a perpendicular and a horizontal tube. The perpendicular tube is for plumbing work to see if it is in an upright position, and the horizontal tube is for levelling the courses of bricks when they are laid, to ensure their being level. The rule is also indented as shown in the centre, this being for holding the level.

This form of plumb rule has been used extensively of late years. The drawback for using the spirit level for levelling and for plumbing is this: If the level is dropped from the scaffold, there is a danger of the tube being put out of its original position, and therefore endangering the exact upright position when plumbing with it.

Two-Foot Rule.—The length of this rule is 24 inches. It is generally made in four hinged divisions for folding up conveniently for the pocket. These are generally made of box wood, about ⅛ inch in thickness. The whole length is divided into inches, and sections showing the eighths, sixteenths, and quarters are marked upon it. The rule is used for measuring work of all kinds.

The Hawk.—The hawk is used in conjunction with the pointing trowel. It consists of a square piece of pine wood about ¼ inch in thickness and 6 inches square. Underneath, it consists of a piece of wood which is rounded off to form a handle. This is used for holding the mortar for pointing. The bricklayer holds the hawk in the left hand. Taking the pointing trowel in the right, he pats the material into a small compact heap, and draws it down to the thickness of a joint. He then takes sufficient material from the hawk with the left side of the blade of the trowel, swings it into a horizontal position,



BRICKLAYER'S TOOLS, I.

1. Brick Trowel. 2. Large Pointing Trowel. 3. Small Pointing Trowel. 4. Two-foot Rule. 5. Three-foot Straight-edge with Horizontal and Vertical Spirit-levels and hole for Lead-bob for Plumbing. 6. Plumb-rule with Lead-bob. 7 and 8. Plumb-rules showing position against battering wall and over-hanging wall.

and places the material into the bed joint of the brickwork, pressing it firmly in to form a good key to the existing material, which composes the bed of the brick. Having done this, he irons or polishes the joint by pushing the trowel backwards and forwards on the face of the joint, pressing firmly at the same time. After this has been done, there is a small surplus of material which has to be pressed out at the bottom of the bed joint. This surplus is required to be trimmed or cut off, so as to make a parallel bed joint. To do this, we have to use two other tools as described in the next paragraphs.

The Hod.—A hod is made of three pieces of wood nailed together, not unlike two sides and one end of a square box, the sides fitted on edge into a pronged iron strap fitted to a stout pole. It is used to carry mortar or a load of bricks up a ladder, the pole being placed over the labourer's shoulder (Fig. 4).

The Pointing Rule—These two tools are used for trimming off the surplus material from the bottom of the bed joint. The pointing rule consists of a piece of seasoned pine wood 3 inches wide and 4 feet in length. One edge is chamfered about 1 inch down, and two small pieces of lath, about 1 inch by ⅛ inch, are tacked to the face of the rule at each end. The length of the rule depends upon the number of bricklayers working it. If one bricklayer works the rule, 4 feet in length is sufficient, but if two work it, a longer rule is required, usually about 6 feet in length.

The Frenchman.—This is really a large table knife, bent over at the extreme end of the blade. This cuts the surplus material from bottom of bed joint. A small angular file is used for sharpening this tool, as it soon gets a blunt edge when being drawn along the brickwork, in cutting the edge of bed joint.

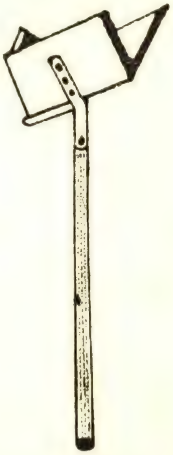


FIG. 4.

The bricklayer usually holds the pointing rule with the left hand, placing it against the wall in a level position and parallel with the top line of the bed joint, the chamfered edge and lath pieces being placed inwards towards the wall. He then takes the frenchman in the right hand and places it at the left end of rule, with end projection or point downwards. Then he moves the frenchman along the rule in an outward direction to the right, thus cutting off the surplus material from the bottom of the joint. The rule, being kept a certain distance from the wall by the lath pieces, enables the waste material to fall between the rule and the wall, keeping the wall clean and not smearing it.

The Jointer.—This tool is made of steel, having a deep blade with rounded end and a bent tongue at the other, fitting into a wooden handle. It is used for tuck pointing in old work.

The Square.—This is made of iron or wood, and is usually measured off in 1-inch divisions. It is used for corners. Steel squares are usually about $\frac{1}{16}$ inch in thickness, in the form of an angle of 90°, and about 1 inch in width. It is sometimes divided into eighths and sixteenths, according to the class of work to be executed.

***Club Hammer* and *Steel Chisel*.**—Two important instruments are the tools known as the " club hammer " and " cold or steel chisel." The club hammer consists of an ash handle about 6 inches to 8 inches in length, with a steel head which varies in shape and weight according to the work required to be done. For instance, if a hole is required to be cut in a very hard floor, the bricklayer would use a large heavy club hammer, as most of the striking required to be done would be in a downward direction, and a greater weight would be obtained in this downward movement, but if the bricklayer is required to cut a hole in a wall or a ceiling, where the direction of the stroke would be horizontal, or in an upward direction when striking, he would then use a much smaller hammer. The weight of a large-size club hammer would be anything between 3 and 4 lb. The small hammer would weigh about 2 lb.

The steel chisel which is used varies in size, both length and thickness, according to the job required. For instance, if the bricklayer had to cut a hole through an 18-inch wall, he would require two chisels. The first would be about 10 inches to 12 inches in length, with which to start the hole through the wall, and cut into it, say, 9 inches. After this had been done, he would require a longer chisel of about 18 inches in length. The chisels vary in diameter from $\frac{1}{2}$ inch to $1\frac{1}{2}$ inches. They are made in round, octagonal, and flat sections.

***Brick Hammer*.**—The brick hammer consists of a wooden handle, generally made of ash, as in the case of the club hammer, and a shaped steel head, square on the striking end. This end is about 1 inch in thickness and 1 inch in width. The other end of the steel head is also 1 inch in width, and then tapers down to form a blade, the extremity of which is about $\frac{1}{8}$ inch in thickness.

This tool is used for tapping down firebricks after they are laid in position, to obtain a very tight or close joint. The blade is used for shaping bricks. By this, I mean, cutting a portion of the brick to form an arch brick for instance, or any other shape which deviates from the shape of the ordinary brick. The brick to be cut is sometimes held in the left hand by the bricklayer, and cut by him whilst holding the brick hammer in the right hand. Of course, there are left-handed and right-handed bricklayers, but in describing the uses of the various tools, I always refer to the right-handed man. In the case of the left-handed man, the position and uses of the various tools would be reversed from right to left, but the principle of using them would be the same.

Bolster—The bolster is also used in conjunction with the club hammer. It consists of a shaped piece of steel, with a blade at one end and a handle at the other, being made in the one piece. The top or handle part is round, and about 1 inch in diameter. The bottom part is in the shape of a semicircular blade, being about $\frac{1}{4}$ inch at the top of the blade, and terminating to about $\frac{1}{16}$ inch in thickness at the bottom of the blade. The width at this part is about 4 inches. These are made in heavy and light patterns. The bottoms of the blades vary from 3 inches to 6 inches in width. The light ones are used for cutting bricks into specified parts, quarter and half of bricks, known as closers and bats, of the stock variety. The heavy pattern is used for cutting bricks of a much harder material such as blue Staffordshires, etc.

The bricklayer in cutting a closer places the brick in a firm position on the ground or scaffold, holds the handle part of the bolster with the left hand and places it in position, the blade resting on the marked division of the brick required to be cut. He then takes the hammer in his right hand and with a hard blow of the hammer strikes the top part of the bolster, which cuts the brick into the required size.

Spirit Level.—The spirit level and short straight edge are generally used in conjunction with one another. The spirit level in this case is called also the pocket level, because it is of such a size that it can be conveniently carried in the pocket. These short levels vary from 4 inches to 9 inches in length, are sometimes in wood—mahogany or oak—or in metal. The one in illustration is 9 inches in length, 1 inch wide, and 1 inch in depth. It has a brass plate on top or face of level, which is screwed down into an ebony case. The tube which contains the spirit is inserted in the centre of the ebony case and the brass plate. This is used for defining levels on the brickwork, and is usually placed by the bricklayer on the short straight edge, to obtain a longer horizontal levelling surface along the brick wall.

Straight Edge.—The short straight edge, which is usually 3 feet to 3 feet 6 inches in length, is made of a piece of good seasoned pine wood or mahogany, $\frac{3}{8}$ inch in thickness. This is divided into twelve 3-inch divisions, cut into the straight edge. These are for the purpose of gauging or measuring the courses of brickwork. For this purpose, the bricklayer places the edge of the straight edge against the wall, in a vertical or upright position, upon the datum peg. (This is a peg which is used for the purpose of taking all the different heights of the brickwork from.) When a greater height than the short straight edge is in question, a 10-foot rod is generally used, marked off into 3-inch divisions.

I have mentioned the datum peg in this case, to show that a particular position should be given to stand the 3-foot straight edge upon. The bricklayer can then see by the lines or gauges on the face of the straight edge if he is rising the courses of brickwork exactly to gauge, which in London and the provinces is four courses of brickwork to gauge 12 inches, rising vertically, each course to measure exactly 3 inches. A small hole about $\frac{1}{2}$ inch in diameter is cut through the straight edge at one end for the purpose of hanging the straight edge on a nail, to prevent it from getting damaged when not in use.

Pins and Lines.—This is quite a simple combination. The pins consist of two shaped pieces of steel, about 6 inches in length and $\frac{3}{8}$ inch in thickness. The top end of the pin consists of a circular head 1 inch in diameter and $\frac{1}{8}$ inch in thickness. The under side of this is the neck of the pin. This is about 3 inches long and $\frac{3}{8}$ inch in diameter and round in shape. The bottom 3-inch part of the pin is of a flat shape, from 1 inch in width, terminating to a point at the extreme end. The neck of the pins is used for the purpose of receiving the line or strong twine which is wound round it. The top circular button-shape piece prevents the line from slipping off the pins. The bottom groined part of pins is used for the purpose of fixing the pin into the cross-joint of the wall, along which the line is stretched. When the bricklayer has, for instance, built up two corners of a wall which he is about to build, he takes one pin, puts it into the first course at the left corner at the top of cross-joint. (This is the left pin.) He then proceeds to unwind the ball of string which is attached to the other pin, and proceed along the wall to the other corner. He then stretches the line as lightly as possible and pushes the right pin into the other corner which he has built. He has then a line from corner to corner, in which to lay the first course of bricks.

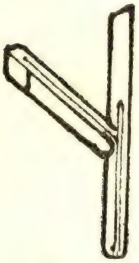


FIG. 5.

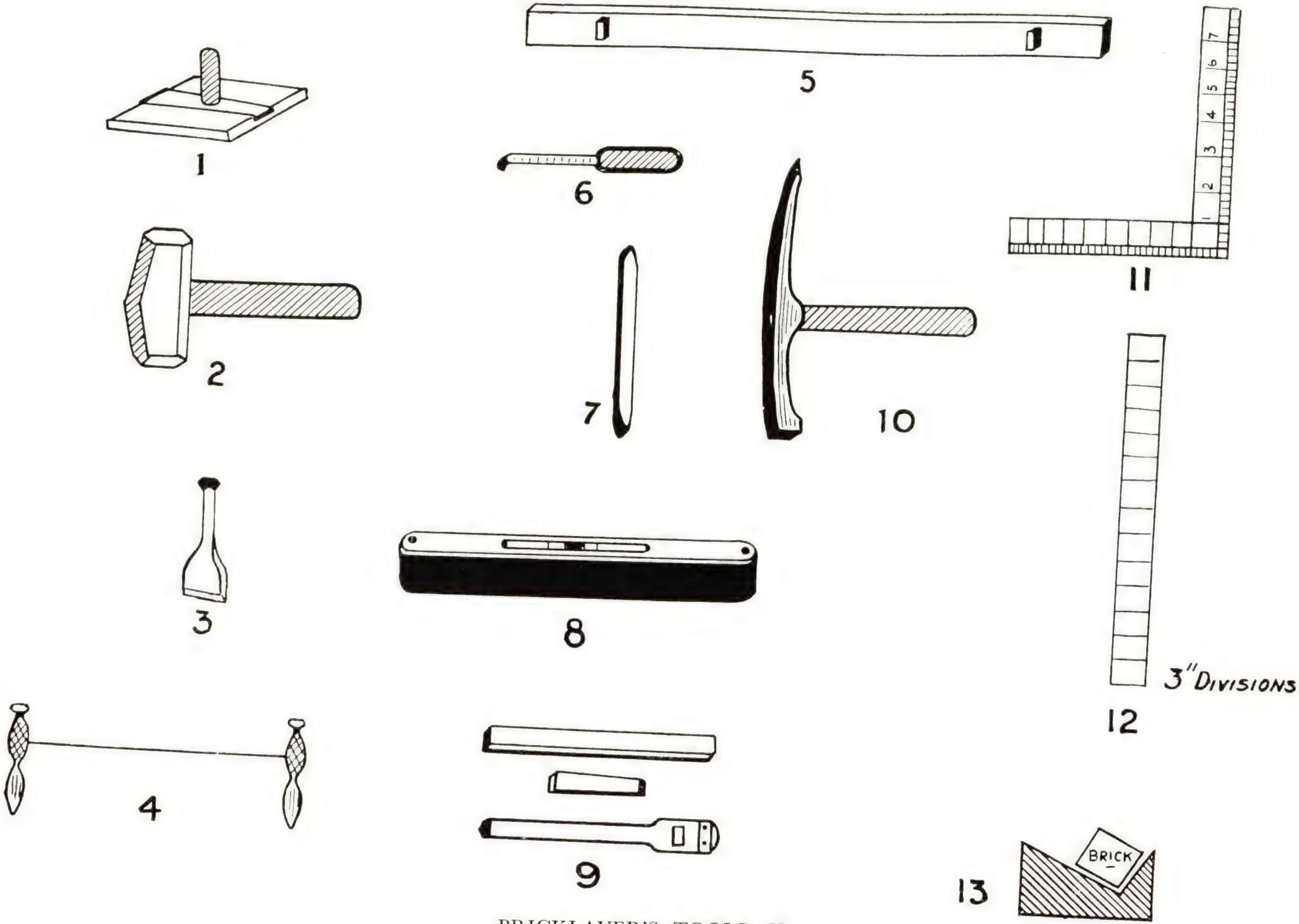
Scutch.—The scutch consists of three distinct parts, the stock, blade, and the wedge. The stock is a shaped piece of ash, the top portion being called the head, and the bottom part the handle. The head is about 1 inch in thickness and 2 to $2\frac{1}{2}$ inches in width, length about 3 inches. The head also contains a slot about 1 inch by $\frac{1}{2}$ inch cut through at the angle of 35°. Into this slot is fixed the steel blade, which is 10 inches by 1 inch by $\frac{1}{8}$ inch and chisel flat pointed at each end. This blade is held in position by means of a hardwood wedge 3 inches in length, tapering from $\frac{3}{4}$ inch to $\frac{1}{8}$ inch.

The scutch is used for the purpose of shaping bricks roughly for the various arches.

Scutch Hammer.—The steel head of this tool is somewhat like a small double edge or double pick with straight ends, and is mounted on an ash haft. It is used for much the same purposes as the scutch.

Cutting Blocks.—This is a plain wooden block used in conjunction with the scutch, for cutting and shaping the bricks. While the brick is held firmly in position in the cutting block, the bricklayer using the left hand for the purpose, he can then cut the brick into the required shape with the scutch. The bricklayer uses the right hand in wielding the scutch in the same manner as that described in using the brick hammer.

Bevel.—A bevel (Fig. 5) consists of a stock which is made of hardwood, and slotted into this is a movable blade, which works on a pivot screw which is inserted at one end of the stock. The



BRICKLAYER'S TOOLS, II.

1. Hawk. 2. Club Hammer. 3. Bolster. 4. Pair of Pins and Line. 5. Pointing Rule. 6. Frenchman. 7. Cold Chisel. 8. Pocket Spirit-level. 9. Scutch, showing blade, wedge and stock complete. 10. Brick Hammer. 11. Steel Square. 12. Straight-edge. 13. Cutting Block.

stock is about 6 inches to 9 inches in length and 1 inch in thickness. The blade is composed of steel 1 inch by $\frac{1}{16}$ inch.

The bevel is used for the purpose of defining various angles as required in the construction of brickwork.

Gauges.—(Fig. 6).—These three illustrations show gauges used by the bricklayer for measuring the various parts of bricks, when required to be cut by the hammer or bolster. They include the three-quarter gauge, that is, three-quarters of the length of a brick, the half-brick gauge or bat gauge as it is sometimes called, that is, the half length of a brick, and thirdly the closer or quarter gauge, which is a quarter of the length of the whole brick. These are made of hardwood of various lengths, according to size, rebated, and are half an inch at the gauge or measuring end, and one inch at the other end.

A brick is laid in position for cutting, the gauge is then placed against the end of the face of the brick and then marked to the required size.

The tools I have mentioned and described are those which are in ordinary daily use, and used by bricklayers on ordinary work, such as footings and walls built in stock and fletton work, also plain work such as housing schemes, factory and warehouse buildings. There are others used. I will describe the tools for special work in a later chapter. These include tools needed for gauge work, such as the forms of arches, tablets, plain and moulded, keys, moulded pediments, niches, etc.

All the tools which are in daily use should be kept very clean. They last much longer in this condition and much better and cleaner work can be done. The whole of the tools when not in use should be packed neatly in a tool bag, and kept in a dry place.

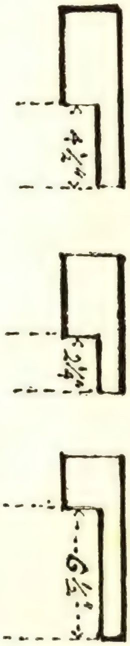


Fig. 6.

Brick Cleaners.—Brick cleaners are made of steel, having a broad scraping edge and a handle, the whole made in one piece. Other patterns are double ended, having two broad scraping faces and a handle in the middle. They are used for scraping down or cleansing old brickwork.

There are a number of other appliances that require brief mention, because needed by the bricklayer in a large or small jobbing business, where apart from straightforward work, such as plain brickwork or the more intricate gauged work, other things have to be attended to, for instance, slate repairing work. For this last class, the following will be required:

Plain Square.—This is a steel square similar to the one used in squaring ordinary brickwork, but in this case plain and not figured.

Zax.—A zax is sometimes used by bricklayers. It consists of a wooden handle to which is attached a steel blade about $\frac{1}{8}$ inch in thickness and about 9 inches in length. There is a spike-like projection about 2 inches long jutting out from the side of the blade which is used for the purpose of making nail holes in the surface of the slate. The blade is used for cutting and trimming the slates into their various lengths and sizes.

The Dog.—Used with the zax, the "dog" is a shaped piece of steel about 12 inches in length and $\frac{3}{8}$ inch in thickness. It consists of a straight upper piece and two pointed spikes projecting downwards at each end. The straight part at the top is used for laying the slate upon at a certain angle, in order that it may be cut by the zax. The two spikes are fixed into a thick wooden block about 9 inches by 3 inches in order to keep the dog in a firm upright position. The bricklayer holds the slate at a certain angle upon the dog with his left hand. It is then ready for cutting, and he holds the zax in his right hand with the blade downwards, striking the slate with repeated blows at the farther end of slate. As he pushes the slate from him, he keeps cutting it until the zax has cut off the required division. The slate is then holed by the spike-like projection, which is done by the bricklayer turning the zax spike downwards and striking it.

Slater's Hammer.—With the above goes the slater's hammer with its shaped steel head, flat at one end, for the purpose of driving slate nails, and pointed at the other, for making holes in the slates. The handle is about 9 inches long and made of ash. About 2 inches along the head from the handle there is a claw-like projection about $1\frac{1}{2}$ inches long and curved in shape. This is used for extracting or drawing out the old nails when repair work is being done.

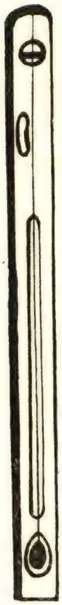


FIG. 7.

Slate Gauge.—A slate gauge is used for marking points and lines on the slates for the position of holes and cuts. It consists of a wooden rod about 1 inch in thickness, and rebated to the required gauge of slate. A nail is generally placed about $\frac{1}{2}$ inch from the extreme end for the purpose of scratching a line or mark on the slate. The slate is held with the left hand, the wooden gauge with the right, with the nail pointing downwards and end of rebate against the end of slate. The gauge is then drawn sharply forwards and backwards across the slate, and in so doing leaves a mark which is made by the point of the nail.

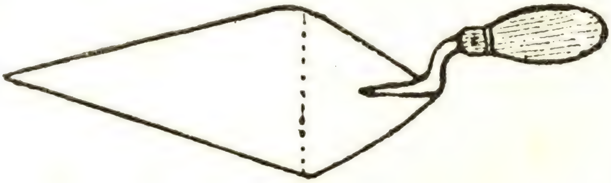


FIG. 8.

Slate Ripper.—This tool is so called because it draws or rips the nails from their position under the slates. It consists of a one-piece shaped steel handle and blade combined. The handle is about 4 inches long and 1 inch in diameter, and the blade is anything from

2 feet to 2 feet 6 inches in length. It has a drop at the handle end downwards of 2 inches at this point. It is about 1 inch in thickness and tapers towards the extreme end to ⅛ inch in thickness. At this end there is a flat piece of steel about 2 inches by 2 inches by ⅛ inch, which has two cuts or indents at the back end. This is for the purpose of clipping round the nail before extraction, when drawing out a broken slate. The bricklayer pushes the thin end of the ripper under the slate with his right hand until the cut or indent at the back of the end piece fixes round the nail. He then gives the ripper a sharp pull towards him, which bends the nails. (Being made of zinc they are very pliable and bend on pressure.) The same process is applied to the second nail. Whilst he is drawing out the slate, which should now be loose, he presses on the handle in a downward direction. This raises the blade slightly at the end, keeping it close to the under side surface of the slate he is going to draw out. At the same time he presses the slate on to the ripper with his left hand, and draws towards him. This brings the slate forward on the surface of the blade, and by this process he draws the slate quite clear.

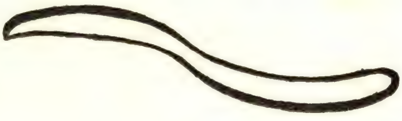


FIG. 9.

There are other special tools for various sections of the trade, such as glazed work and tile work. These branches require a number of small chisels, a cutting wheel, diamond, etc., for cutting the surface of the glaze.

The special tools for gauge work will be dealt with in a subsequent chapter.

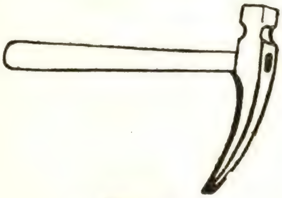


FIG. 10.

Canadian and American Variations.—Before closing this chapter it will be well to mention two Canadian and American variations of well-known appliances. Fig. 7 shows the plumb line, bob and line. It will be seen that it is much like that used in England, but has a slot, 5 inches long by 1½ inches wide, near the top of the rule. This enables the rule to be firmly grasped when plumbing external angles.

Fig. 8 shows the large brick trowel, which, as the dotted line indicates, is exceptionally wide at the shoulder. This is done so that the bricklayer in bending over to finish the external part of the wall may collect the surplus mortar. In this way very little material is lost.

Other tools used in Canada and America are the jointer (Fig. 9) and the brickhammer (Fig. 10).

I will describe the Canadian and American methods of bricklaying in a later chapter.

CHAPTER V

PRELIMINARY CONSIDERATIONS

Plan—Section—Elevation—Isometric View—Parts of Bricks—King Closer ; Queen Closer ; Ordinary Closer ; Bat or Half Brick ; Three-quarter Brick ; Face ; Face Header ; Face Stretcher—Frog—Corners—Preliminaries to Bricklaying—Taking Levels—Bonds—Stock Work —Glazed Work—Brickwork for Heavy Loads—Grouting—Flettons—Rough Work.

BEFORE considering the practical side of bricklaying, it is necessary to become familiar with preliminary matters. Certain technical terms and what they imply must be thoroughly understood before the operative is fitted for his task and is enabled to pass from the elementary to the more advanced stages of his craft.

Plan.—A plan of any object is the representation of the view which is obtained when looked at from a point above that object. For instance, we will take an example of the plan of a brick resting upon its bed. The plan of the brick would be the surface of its top portion, showing the length and the width, 9 inches by 4½ inches. The frog would also be seen as shown in Fig. 19.

The plan of a building would also be the representation of the view which is obtained when looked at from a point above it.

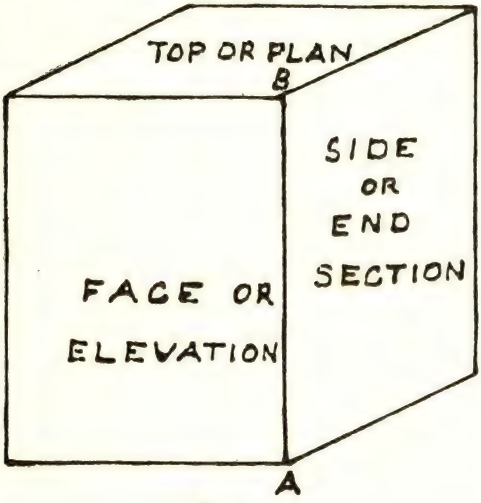


FIG. 11.

Section.—The section of any object is the view obtained when that object is cut through either vertically or horizontally. Again we will take a brick as the example. Figs. 13 and 14 show vertical sections cut through different points of the brick.

Elevation.—An elevation is the representation of the view obtained of any object by looking at it in a vertical direction. For instance, if we stand in front of a house and look at the face of it, the view we obtain by doing so is called the elevation. After having obtained the view of the elevation, plan, or section, by looking at the object from different views, points, or angles, we have to transfer our mental pictures by drawing them on paper. This gives us the representation of them.

Fig. 11 is a cube showing plan, section, and elevation.

Isometric View.—There is also another view of the brick (or other object) called the "isometric view," Fig. 12. This is the representation of the brick or other object when looking at it from such a position that we are able to see three views at once, that is to say, the plan or top of brick, end of brick, and side face of brick.

Parts of Bricks.—The other figures give an illustration of the various parts of the brick when cut, for the purpose of obtaining the correct bonds in various walls.

Fig. 13 is called a "king closer." It is 9 inches on the top side, 4½ inches in width, and 3 inches in thickness. The portion shown with the shaded lines is cut away from the brick, leaving 2¼ inches at the end face and 4½ inches at the side. Fig. 14 shows another form of a "king closer."

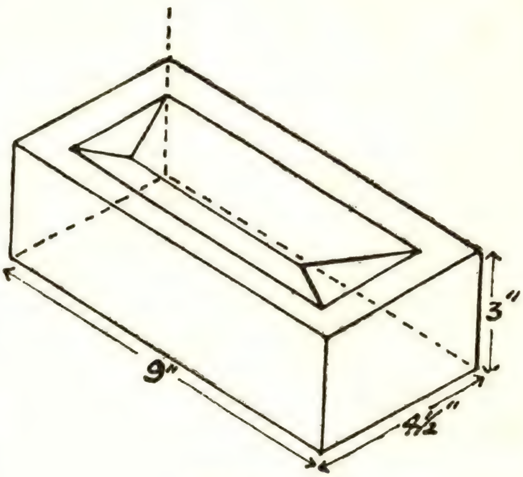


FIG. 12.

Fig. 15 illustrates the part of a brick which is called a "queen closer." This is half the brick cut longitudinally. The whole brick being thus cut would make two queen closers. They are 3 inches in thickness, 9 inches in length, and 2¼ inches in width, that is, the horizontal width shown on face.

Fig. 16 is called the "ordinary closer." If care is taken, four of these can be cut from the one whole brick. They measure 3 inches in thickness, 4½ inches depth back from face, and 2¼ inches horizontally across the face. The illustrations of these three kinds of closers show them in plans.

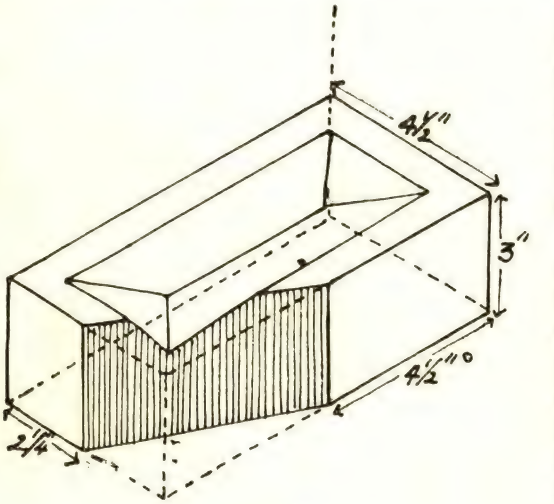


FIG. 13.

Fig. 17 is the elevation of the half brick, or "bat," as it is called. It measures 4½ inches across the face horizontally, 3 inches in depth on face, and 4½ inches in length back from face of brick. Two of these can be cut from the one whole brick.

Fig. 18 is known as the " three-quarter brick." It measures 3 inches in depth, from 6 inches to 7 inches in length on the face measured horizontally, and is the width of the brick back from face of wall, that is, 4½ inches.

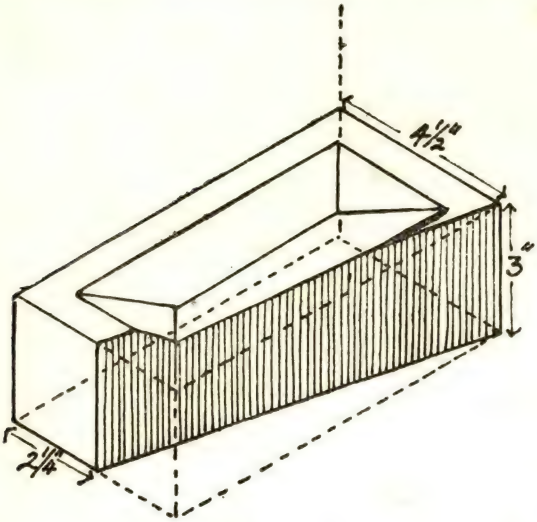


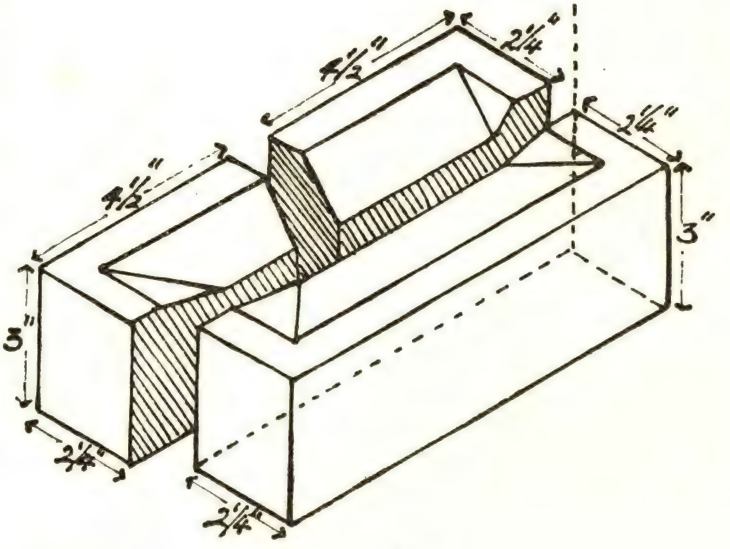
FIG. 14.

Fig. 19 is an illustration showing an isometric view of the brick giving the length, breadth, and thickness.

The part which shows the face end of the brick is known as the " face header." The bricks are laid in the heading course as in English bond, showing this surface to the face of the wall. The remaining surfaces, including bed and frog of brick, and also sides and end of brick, are in the interior of the wall. The face side, as shown in illustration, is known as the " face stretcher " as in English bond again. This face forms one of the bricks laid in the stretching course, and faces to the front or face of the wall. The other parts such as the two ends, back side, and bed and frog, are built in the interior of the wall and not seen.

The underneath side of brick is known as the "bed" of the brick. This surface lays downward upon the bed of mortar.

The top, or upper surface of the brick, is known as the " frog " side of the brick. The brick should always be laid with this frog facing upwards.



FIGS. 15 and 16.

The frog is a depression made in the top surface of the brick and forms a key for the bed of mortar between each layer of bricks. It has also the advantage of reducing the weight of the brick, and, where a large number of bricks are made, it has a special bearing as regards economy. Some bricks are made with one frog, or single-frogged bricks, others with two frogs, one forming the upper and the other forming the lower surface of the brick.

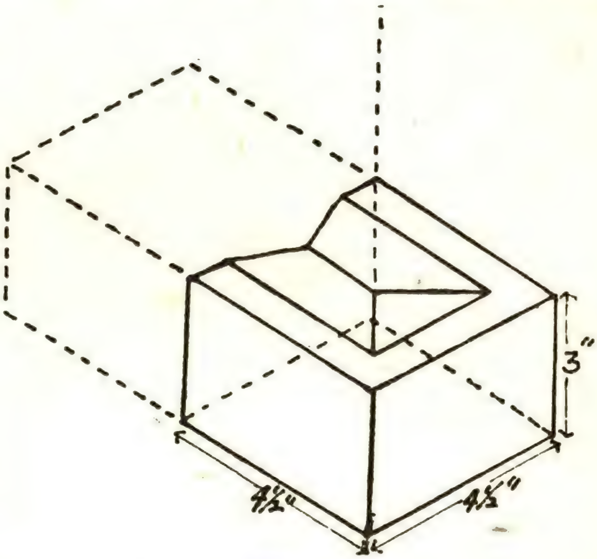


Fig. 17.

The angles of the bricks are known as "corners."

Fig. 20 is an illustration of a plan which shows a nine-inch wall, the bricks being placed as stretchers along the stretcher course.

Fig. 21 shows the plan of the same course of stretchers, with the addition of the dotted lines seen running across the width of the wall. Whenever a dotted line of this kind is shown, it indicates that there are lines beneath or behind the plan or surface shown. The dotted lines as shown in this figure represent the lines of the course below it, which in this case are headers. It will be seen in the plan of the heading course, as shown in Fig. 21A, that the dotted lines are extended from the heading course plan to the stretching course plan, so showing the position of the heading course below the course of stretchers.

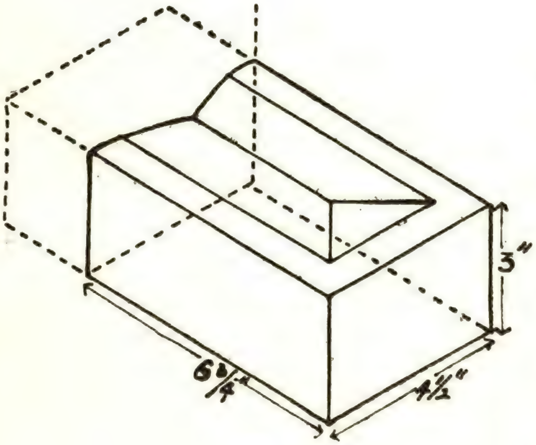


Fig. 18.

Figs. 23 and 24 illustrate two sections of the elevation where the dotted lines occur, that is, AB and CD. These sections show the bricks lying from the face of the wall to the back of the wall, or, in other words, you see the width or thickness of the wall. The cross joints seen in this section are internal wall joints of the nine-inch wall.

The bed joints are those which run from the face to the back of the wall, if a section of the wall were cut through the nine-inch wall, as shown in the plan, Figs. 20 and 21, marked with dotted lines OO. This longitudinal section would show the backs of the stretcher bricks, and the halves of the headers would be cut through, thus showing the frog at top.

Fig. 22 is the elevation of a brick wall built in English bond. This shows two dotted lines, AB and CD, extending in a perpendicular position from the bottom to top on face of the elevation. These dotted lines represent two points at which a section of this wall is to be shown; or in other words, the view at this particular point, supposing the wall was cut through where the dotted lines show.

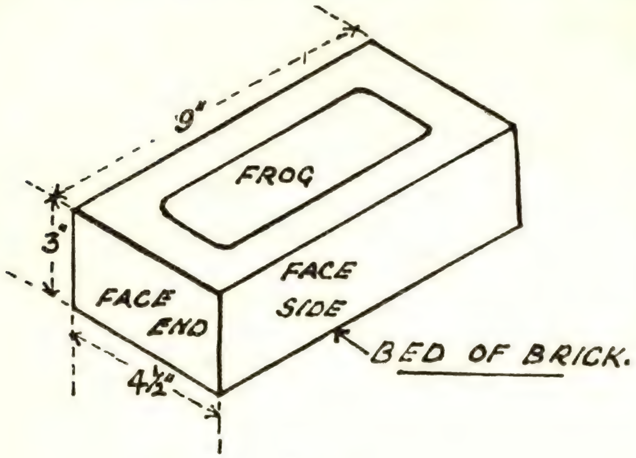
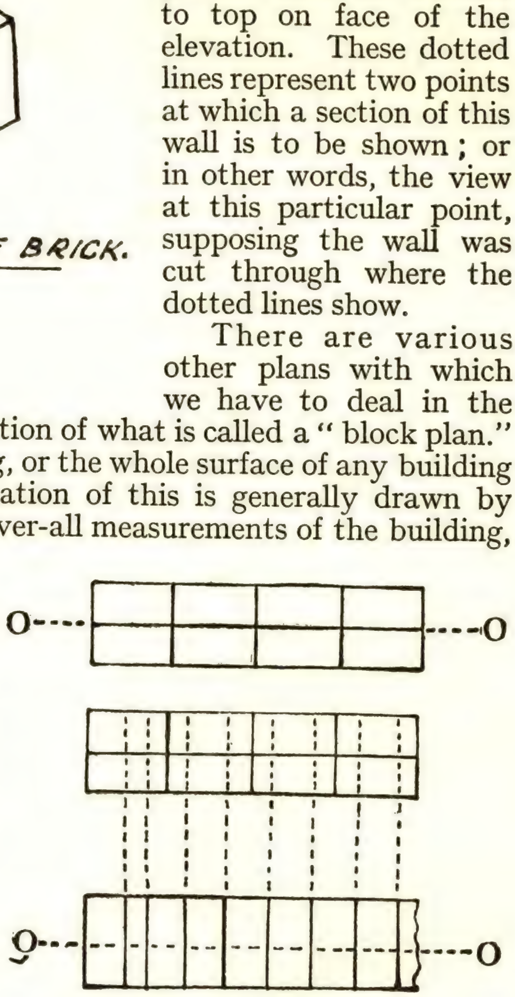


FIG. 19.

There are various other plans with which we have to deal in the building trade. Fig. 25 is an illustration of what is called a "block plan." This consists of the area of a building, or the whole surface of any building when looked upon. The representation of this is generally drawn by single lines. These lines show the over-all measurements of the building, or the outside face of all the walls. Block plans are usually drawn to show the allotted area, that is, the house and the surrounding ground, and its various boundaries. In this case, the plan shows the front of the house with a bay window, and the forecourt. The yard is shown at the back, and the two boundaries at each side.

Fig. 26 is an illustration of a plan showing the outside walls of the house which are lined. It is a plan used for setting out the exterior of the house.



FIGS. 20, 21, and 21A.

Figs. 27, 28, and 29 are the front plan, section, and elevation of a small cottage. The elevation shows the front of the cottage, or a representation of the view that would be obtained by looking at it horizontally. It illustrates the whole face front of brickwork, window and door openings, height and width of these, and their positions in the elevation. In

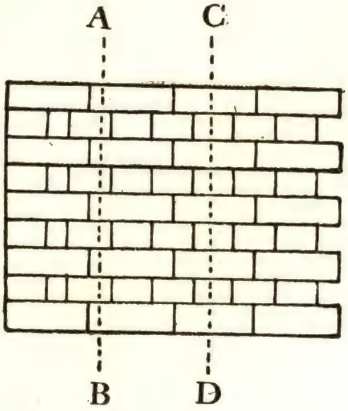
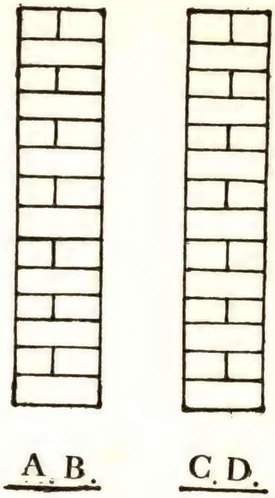


FIG. 22.



FIGS. 23 and 24.

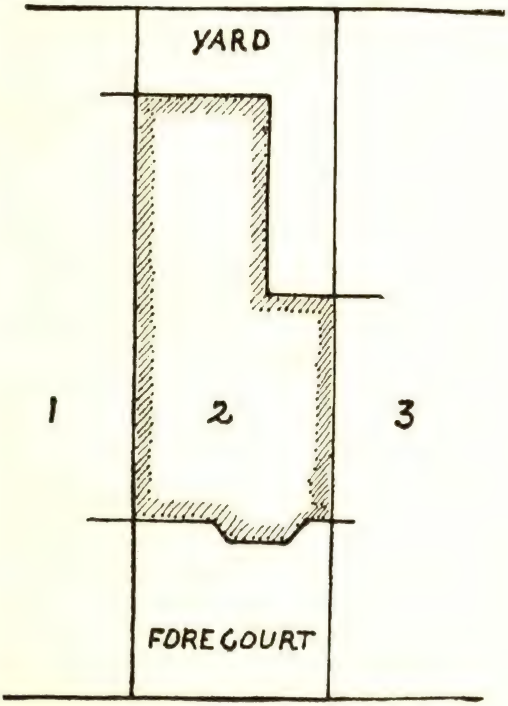


FIG. 25.

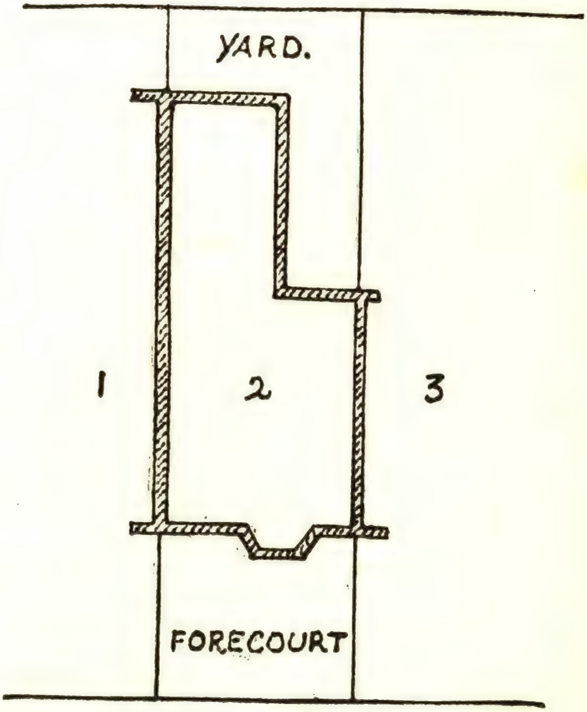


FIG. 26.

Fig. 27 we have an illustration of the plan of the front elevation, this time showing the width of walls, position of doorway and window openings, which should be set out from this plan. Fig. 28 shows a section which has been taken from a point in the plan AB, with a dotted line. This section again gives the various heights required from the footings to the roof, also the height of each room from floor to ceiling and also the height from the floors to the window-sills.

The illustrations of plan, section, and elevation of the walls and buildings have been given in this chapter so that the meaning of the words plan, section, and elevation should be fully grasped. At a later stage, the method of setting out buildings and taking measurements from plans will be given, and full details will then be given, which will be of a more advanced nature.

PRELIMINARIES TO BRICKLAYING

Taking Levels.—When starting to construct any piece of brickwork, the correct levels should be taken, so that the first course of brickwork is laid horizontally, perfectly level. Having taken the correct levels for the first course, the bond which is to be used should be set out, so that each perpend or cross joint is perpendicular, one above the other. At the same time, all openings (window and door), piers, recesses, etc., should be set out. Having started correctly, the bricklayer should use his head as well as his hands as he proceeds with the construction. All work should be kept neat and clean, especially all classes of face work. This the bricklayer will succeed in doing by taking his material off the mortar board in a neat and clean manner, and laying or spreading just sufficient mortar to bed the bricks properly. By doing this, he can remove what little surplus material there is (which squeezes out of the bed beyond the face of the work) with little difficulty, by using the trowel in the correct method, and keeping the face of brickwork neat and clean, which I explained previously. If the bricklayer works in a careless manner, picks the material from the mortar board in a slovenly manner, drops a portion of it on the scaffold, and also places too much on the wall for the bed of the bricks, he will have a surplus which will fall down the face of wall when placing the brick into its correct position. This will smear the face work and make it look untidy; at the same time, there is a mess all around his feet, which makes it uncomfortable for working.

Stock work, which is extensively used at the present time, forms a very fine and pleasing effect as face work for elevations. The bricks should be kept clean, all the joints uniform and to gauge. The bricks should also be picked so as to form a good uniform colour, which is a golden yellow. Red bricks form also a fine elevation, and present a warm appearance. Their colour and joints should be uniform, and the face of bricks kept very clean, for smudges show up much more on this

PLATE

BRICKLAYERS SETTING OUT WORK

Two bricklayers are seen laying out work. The operative on the left is testing with the square the inner angle of a Z-shaped pier with two square stop ends. The one on the right is placing in position bricks according to the bond decided for foundations, or a pier, with two courses of footings.

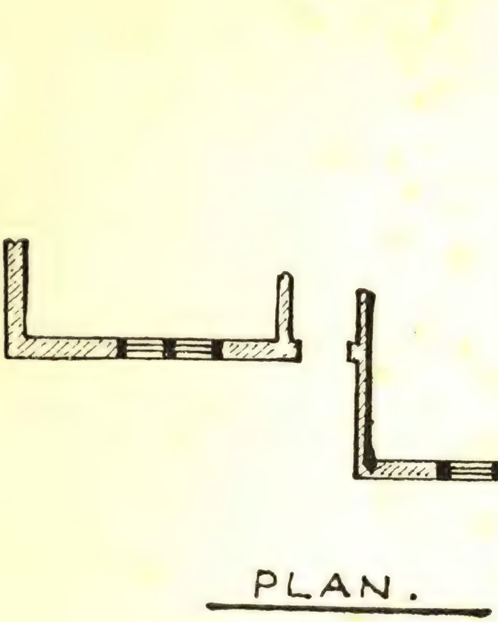


FIG. 27.

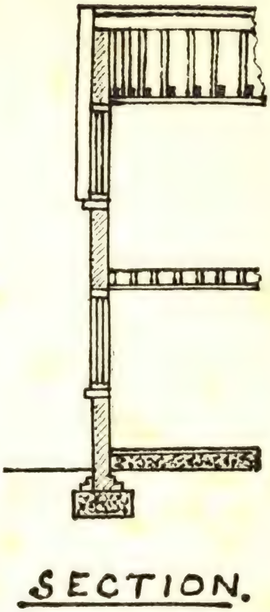


FIG. 28.

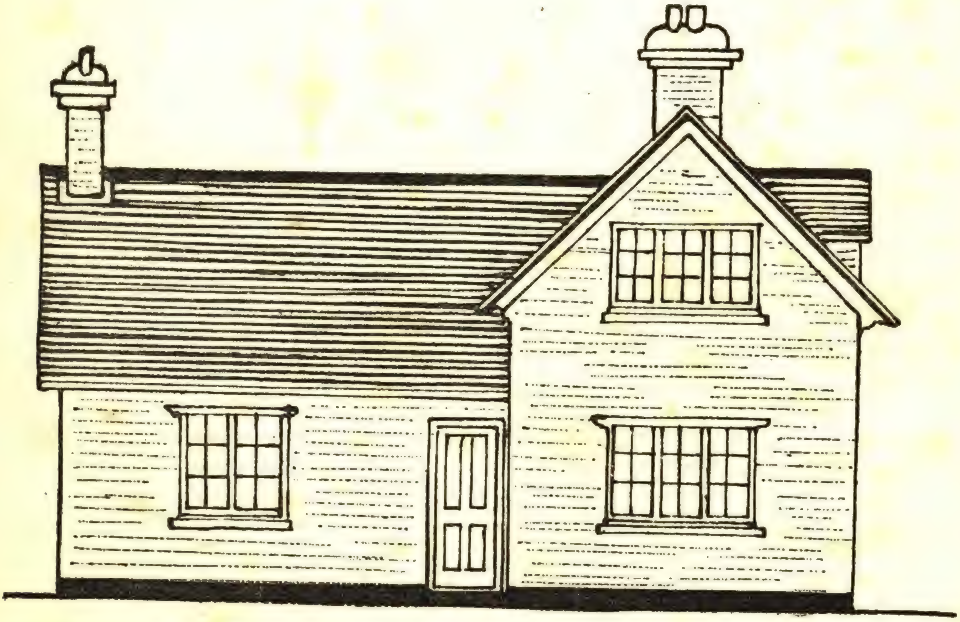


FIG. 29.

class of work than they do on stock face work. Glazed work is of a different nature from the two just mentioned. The bricks are made in a large variety of shapes and colours, and the joints in glazed work are much finer than in the stock and red work. To produce good work, the bricks should be kept in a thoroughly perpendicular position, and at right angles to the face, all perpends kept upright, uniformity in all bed and cross joints, and correct bond worked. (This applies to all classes of work, whether rough work or face work.) The work should be kept neat and clean, and the bricks should be carefully handled, so as not to chip the glaze and deface them.

Stock work and red brickwork generally form elevations to buildings such as houses, shops, offices, etc., Glazed-brick work is used for light and cleanliness; for instance, to line areas and walls at the back or centre of large city offices, where the maximum of light is required. They are also used in hospitals, bakehouses, shops, kitchens, bathrooms, lavatories, etc., where cleanliness is very essential. In all these instances, the glazed brickwork can be washed down periodically where the dust collects on its surface. This can be done by the use of the hose pipe and water.

Great care should be taken in bedding the glazed bricks, so as to ensure a thin solid bed to each brick. When using glazed bricks which have two frogs, one at the bed and the other on the top surface of the brick, the usual method is to fill up the bed frog before bedding the bricks on the wall. This ensures a solid joint; otherwise, if the frog is not filled in this manner, there is a risk of the under frog being hollow in places. A much finer mortar is used for bedding glazed bricks, generally the materials to be used are passed through a sieve to eliminate all the larger particles which exist in the sand. This method is used so as to ensure a small neat joint in the glazed work.

In the stock work and red work, a good pit sand is generally used, and in this case it does not require the sieve, owing to the fact that the joints in this class of brickwork are much larger, and the size of the particles in the sand is not noticed in bedding the bricks in this class of work. The bed joints and cross joints in stock work generally average about $\frac{3}{8}$ inch in thickness, and the joints in glazed work about $\frac{1}{8}$ to $\frac{3}{16}$ inch in thickness.

Brickwork for Heavy Loads is a different class of brickwork which is used in the construction of various kinds of work required to carry heavy loads, and where exceptional strength is required, such work as large piers and buttresses on railways, etc., for which the blue brick is used. This class of brick is also used extensively in banks, for the construction of their strong rooms. These bricks are selected for these purposes on account of their great compression strength. Well-laid brickwork of this kind will carry a safety load of 12 tons per square foot. Of course, this result is obtained in conjunction with the proper material, which should be used in bedding these bricks. A good clean angular-grained sand should be used in proper proportions with a good Portland cement up to standard specification. The blue Staffordshire brick is heavy and practically non-porous. It should be kept in a dry place before using, and great care should be taken in bedding these bricks. The material used for bedding should be of the proper gauged consistency, and not made too soft in mixing. It should be more of a stiff paste nature, and just sufficient material should be used in bedding the brick. This is most important in the case of the blue brick, for once the brick has been placed on the wall in its proper position, it should be left alone. If it is tapped several times with the trowel after it has been put in place, it will cause the bed of material to become soft (there being practically no suction in the brick to absorb the moisture from the bed, as in the case of the stock and red brick). This will cause the brick to slide or move slightly from its original position, and also cause the bed material to squeeze out from under the brick and run down the face of the work. Again, by tapping, the brickwork will probably overhang, owing to the bricks slightly moving from their bed position. So it will be seen how important it is to make up the material in the proper consistency, and when placing the brick in its position, to leave it there.

It is necessary to lay stress on those one or two points about the mortar, because they are the things which actually occur in everyday practice to the bricklayer who is not thoroughly acquainted with this class of brickwork.

The joints in this class of work average about $\frac{3}{8}$ inch in thickness, but vary at times with the thickness of the bricks and also the gauge. Some of the blue bricks have single, and others double frogs. These are the Staffordshire blues. Another class of brick used in internal work of large piers and buttresses are blue wire cuts. All internal work of this description (third or fourth) should be thoroughly bedded and grouted in at each course. At the same time, proper sectional bond should be carried out in all internal parts of walls. This means strength to the walls and buttresses.

It is as important, if not more so, to use the correct sectional bond internally, as it is externally. In the case of bad bond internally, the defect is sometimes not noticed, and the defect remains. In the case of the external defect occurring, it is usually noticed at once, and quickly remedied.

Grouting.—Grouting, which is filling up with thin, semi-fluid mortar, is often overdone in blue brick and other hard brickwork. If the bed joints and internal sectional joints have been properly attended to, a formal solid mass will be secured without the grouting of each course. When work is grouted in every course, there is a great tendency for the bedded bricks to slide from their original position. Then perhaps four or five bricks will be practically touching each other, while others will be farther apart, so that the latter have excessively wide joints, while the former have no sectional or internal joints. The result is that by the bricks moving, due to excessive grouting, the internal joints are not uniform, while the correct bond internally may be thrown or moved out of its original position. There is also another danger, that of the grout finding its way through to the face of the brickwork, and running down the face from the bed joints. This is likely to occur unless the face bricks have been bedded very solidly.

The face of blue brickwork should be kept as reasonably clean as possible. After the work has been constructed, the joints are usually raked out to a depth of $\frac{3}{4}$ inch, and then rubbed well with a piece of coke and water. This generally removes the cement marks from the face of the wall. It is then pointed with Portland cement or cement and sand, and when this is sufficiently hard, it is finished off with some oil rubbed on the face with a piece of dry clean rag. This tones it down and gives it a clean appearance.

Blue bricks are sometimes used for yard paving and stables, where there is exceptionally hard wear anticipated.

The blue bull-nose brick is another form of blue brick specially adapted for external corners where there is a lot of hard wear and rough usage likely to take place. This brick is rounded on the corner. There are single and double bull-nosed bricks in use. Great care should be taken by the bricklayer in bedding these corner bricks, so that the radius of the bricks laid on each course should follow one another in a perpendicular position at the bull-nose. If one is slightly back from the face or battering, or if the reverse occurs, and the brick is slightly forward from the perpendicular face, and overhanging, they will form a nasty ridge on the radius.

This is a very important point in making quite sure that the centre point of the external radius as well as the two sides are in a correct upright or perpendicular position. All those points should be carefully watched when this class of work is being constructed.

Flettons are in great demand at the present time. They are used by the bricklayer throughout the country, and when laid with care and neatness they make a good internal face. The fletton is, no doubt, a very good brick for the bricklayer to handle, on account of its being uniform in shape and thickness. This class of work is generally pointed or struck as the work proceeds. This is done by the bricklayer drawing his brick trowel along the bed joint and cross joint, by holding it in a flat position against the wall in each case. The surplus material which is pressed out from the joint in doing this is cut off by the edge of the trowel which is run along the bed joints, the cross joints being cut in the same method.

Rough Work.—By the term " rough work " is meant all classes of work where the brickwork is left in its rough state. This roughness is left for the purpose of forming a key for the plaster in which most of these walls are finished. Although the term " rough wall " is applied, it does not imply that the actual work should be constructed in a rough or slipshod manner ; this term only applies to the external faces of the walls. In this class of work, the bricklayer should take care to lay and spread the beds properly, and also put the bricks into their proper positions as regards the various bonds, and also the correct perpendicular positions of the walls. They should all be level as regards their horizontal positions as well.

CHAPTER VI

THE BONDS

Cross Joints—Bed Joints—Wall Joints—Correct and Faulty Bonding—Various Bonds: English Bond ; Flemish Bond ; Application of English Bond ; Application of Flemish Bond ; Laying Old English Bond ; Laying the Flemish Bond ; English Garden Wall Bond ; Flemish Garden Wall Bond ; St. Andrew or English Cross Bond ; Mixed Garden Wall Bond ; Dutch Bond ; Stretcher Bond ; Ranging Bond ; Paving Bond ; Diaper or Chequer Bond ; Zigzag Bond ; Diagonal Bond ; Herring-bone Bond—Window Openings—Broken Bond—Projecting Piers.

THE word "bond," of course, means the union, or binding together, of two or more objects. In bricklaying, the word stands for the methods adopted for binding together two or more adjacent bricks, that is to say, bricks laid side by side in one course, with each brick pressing on two or more bricks in the course below them.

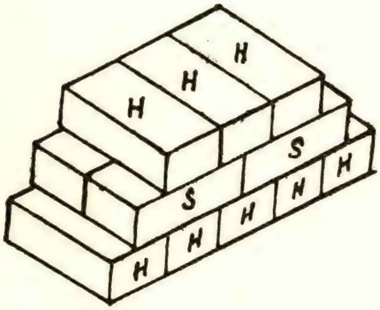


FIG. 30.

In bonding, it is also essential that every joint between the bricks, which is a cross joint, should be confined to the perpendicular thickness of one course of brickwork. It should not extend into the course above or below it, or come into contact with the cross joints in the course below or above. By arranging the bricks according to this method, the formation of what is known as breaking joint or quarter bond is secured, that is to say, every perpendicular cross joint which shows on the face of the brickwork is 2¼ inches apart, or a quarter of a 9-inch brick.

Bonds are systematic arrangements of bricks, laid or bedded in a special manner. This means that the bricks should be bedded horizontally, level and square to the face of the wall, and also in correct bond. By this means, the weight of the brickwork is equally distributed over the foundation. Without this bonding, the weight of the wall would be very unequally spread over the foundation.

Bonding of all brickwork should be well studied, as it is very important in all classes of work, whether rough or face work, and also very important on all internal brickwork. This internal work is called sectional bond, therefore the bond should show the correct method on the face of the work, and also throughout the thickness of the wall.

Cross Joint.—A cross joint is the material or mortar which is placed in a perpendicular position between two bricks extending from the bottom to the top of the brick as laid in the ordinary way, that is, from one bed to the other.

Bed Joint.—A bed joint is the material or mortar which is spread horizontally in order to receive a course of bricks, or the material between one course of bricks and another.

Wall Joint.—The wall joints which form the sectional joints are the material which is placed between the bricks in the interior of the wall in a perpendicular position between each face of the wall, the bed joint running horizontally from face to face, that is, the whole thickness of the wall.

Correct and Faulty Bonding.—Having explained the manner of placing the bricks and the different joints used, we will now take example Fig. 30, which shows the position of several bricks, three courses in height, laid in the correct bond. It will be seen that the three headers on the top course rest on the four stretchers in the second course, and the four stretchers rest upon five headers in the first course. Therefore, the three headers in the top course are distributing their weight over a larger area, namely the four stretchers, and again, the four stretchers are resting upon the five headers and are in turn distributing their weight over a larger area. So it will be seen that the weight of the three headers finally spreads itself over a much larger area, and covers the area of the five headers in the first course. This is what is meant by bond spreading equal weight over the foundation.

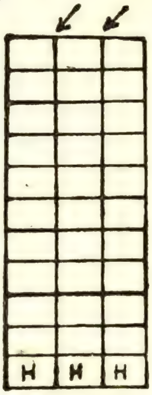


Fig. 31.

Fig. 31 is an example showing a number of headers placed in a certain position, which forms a series of straight joints as indicated by the arrow at the top. This is a very bad form and, as will be seen, the cross joints extend the thickness of a course, which forms a very weak construction. A similar construction is shown in Fig. 32, but in this case it is formed of stretchers showing the straight joint extending from the top to bottom, which would have the tendency to open at the top if a weight were placed upon it as indicated by the arrow. These two figures show the weakness in construction when a correct method of bonding is not used.

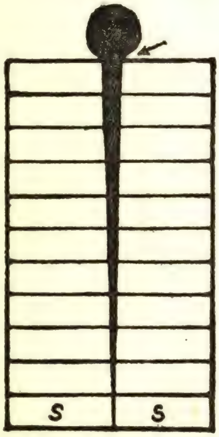


Fig. 32.

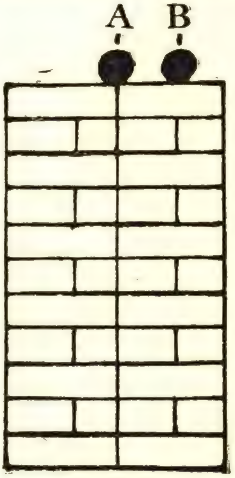


Fig. 33.

Fig. 33 is another bad and weak construction, but slightly better than Figs. 31 and 32. The straight joint is shown in the middle, but the proper bond is formed at either side. A weight put on top of the straight joint A would result in the parting of the two sections; a weight put at B would not have the same tendency to open the joints, which would withstand the weight because in this half section the bond is properly formed so as to be able to withstand the weight placed upon it.

Fig. 34 is an elevation showing the correct method of bonding. It is an example of Old English bond, and shows the weight placed centrally at the top of the wall on the header. The dotted line thus shows the equal distribution of weight over a large area of the foundation at the base. Thus we see the meaning of bricks being placed in such a position as to distribute the weight equally over the foundation.

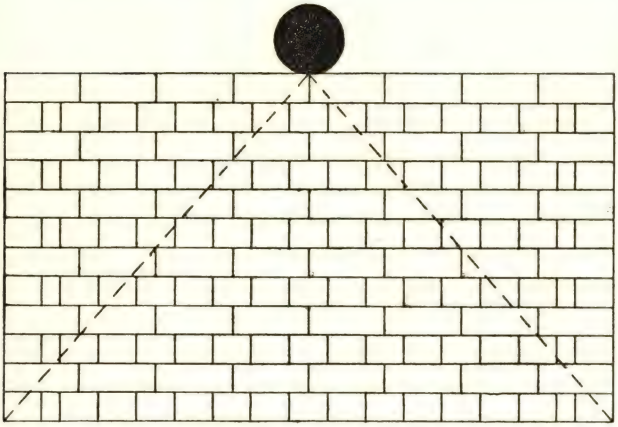
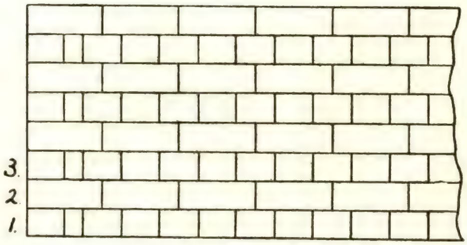


Fig. 34.

Various Bonds

There are various bonds used in brickwork, the two chief ones being English, or Old English Bond as it is sometimes called, and Flemish Bond. There are several other bonds, but these are really variations taken from the English and Flemish.

English Bond.—The English bond consists of one course of headers and one course of stretchers placed alternately. The course in which the headers are used is called the header and the course in which the stretchers are used is called the stretcher course. The first course in a 9-inch wall usually starts with the header, but in order to obtain the correct bond, the closer is introduced next to it. The first header and closer form three-quarters of the stretcher, so when the next course is laid or bedded upon the headers, the stretcher which starts from the corner will come a quarter of a length of the brick beyond the header and closer already bedded in the course below, and this will form the quarter bond in each course of headers and stretchers.



ENGLISH BOND.

Fig. 35.

All perpends or cross joints should be kept in a correct perpendicular position in each course.

Fig. 35 gives an illustration of the elevation of bricks laid in English bond. When uniform bricks are bedded in this way, that is, all the lengths of the stretchers and widths of the headers are the correct sizes, it is then an easy matter to keep the perpends upright; but when bricks vary in length, there is a tendency sometimes to overrun the 2¼ inches, and in doing this there is the danger of one joint coming almost on top of the other perpendicularly. This is what is termed a straight joint. This, of course, is very bad bond. When this occurs, the rule of proper bond is broken, as the cross joint exceeds the thickness of one course of bricks and extends perpendicularly to two courses of brickwork. This makes a weak point in the wall, and causes unequal weight distribution. If these straight joints occasionally occur in a wall, they will soon cause serious defects, and may lead eventually to a crack in the wall, caused by the weakness at the points where the straight joints appear.

English bond is the strongest because all whole bricks are used in the wall except at the angles, where the closer is used, which is necessary for the working of the correct bond.

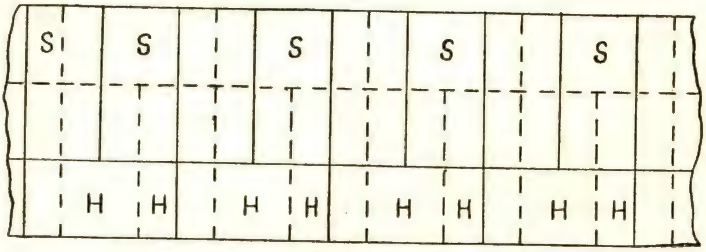


FIG. 36.

Flemish Bond.—In Flemish bond there are a good many broken bricks used. For instance, in the standard thickness wall, which is one and a half bricks in thickness, the middle portion of the wall, or one-third the thickness of the wall, a bat or half brick is placed at intervals of 9 inches longitudinally along the wall. These bats form a series of straight perpendicular joints in the interior of the wall, thus causing a great weakness.

Flemish bond is divided into two divisions, single and double. In double Flemish bond, we have a Flemish bond showing on the face of the work, that is the exterior, and also Flemish bond showing on the interior or back face of the wall. In single Flemish, we have the Flemish bond showing on the face of the wall, and English bond showing on the interior or back face of the wall. The single Flemish bond is stronger than the double Flemish. The English bond which forms the inside section of the wall strengthens and reinforces the single Flemish.

As stated, these are the two chief bonds which are used universally.

Application of the English Bond.—Fig. 36 is an illustration of the plan of a one and a half brick wall, built in English bond. The first course which is laid is shown by lines, that is, one course of stretchers on the exterior face of the wall, and a course of headers laid at the back of these, the face of which forms the internal face of the wall. This wall, which is one and a half bricks in thickness, is called the standard wall from which all measurements of walls are taken. This plan is drawn especially to show the strength in English bond as compared with the Flemish. The dotted lines show the second course of bricks which are laid, and it will be seen that all the perpendicular joints (as shown by these dotted lines between the bricks in the second course) come quarter bond over the bricks which are laid in the first course. That is to say, no perpendicular joint in one course comes perpendicularly over another joint in any other course, the course above or below it. I have marked with an H all the headers, which it will be seen cover the stretchers on the face of the wall, and half cover the headers at the back portion of the wall. The stretchers marked in dotted lines in second course, and marked S, cover the remaining half of the headers in the first course, which are laid on the internal part of the wall. Thus every brick in English bond covers the joints in the course below. Thus a stretcher laid quarter bond will cover two perpendicular joints of two headers extending from the face of wall 4½ inches inwards. A header laid on the face of the wall will cover one perpendicular joint between two headers in the course below it, or the middle 4½ inches portion of the wall joint, and also the 4½ inches middle portion of the perpendicular joint of one stretcher, or the joint at the back of the stretcher. Or the header, if placed in another position or next to the one just mentioned, will cover the two quarter, perpendicular joints at the back of two stretchers.

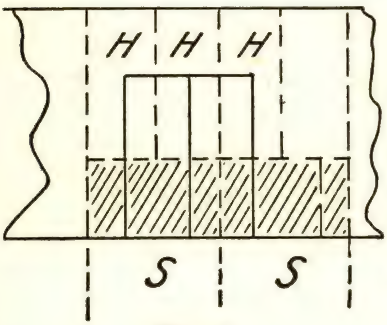


Fig. 37.

Fig. 37 gives the plans of the two headers in different positions. In Fig. 37, the header is placed centrally on the stretcher below, the dotted lines showing the joints covered, and the other header is placed next to it and on a quarter of the length of two ends of two stretchers. The dotted lines in this case show the joints which are covered by this header. The stretcher, as shown, is placed over three headers in the course below, completely covering the 4½ inches front part of the middle header, and one-half of the 4½ inches section or front part of the headers on either side of the centre one. It is on account of this complete covering of joints, and also that in English bond all whole bricks can be used except when the closer is used for forming the bond, that strength and equal distribution of weight over the foundation is obtained.

In English Bond a stretching course is never used in the interior of the wall. If the wall to be built is 18 inches, or two bricks, in thickness, the heading course will show headers on the internal and external faces of the wall and also in the interior of the wall. The course above will show stretchers on the internal and external faces, but the interior of the wall will consist of a heading course. With a wall of two and a half bricks in thickness one course will show headers on the external face and stretchers on the internal face, and the next course will show the reverse, but in each case the course in the interior of the wall will be a heading course. From this it will be seen that when the thickness of a wall is the exact multiple of a whole brick, the external and internal faces of the wall will show alike in each course of brickwork; but if the wall is not the exact multiple of a whole brick in thickness, and contains an extra half brick, the courses on the external and internal faces will be different because the extra half brick will be shown as a stretching course on the external face on one course and the internal face on the next, and will not be laid in the interior of the wall. When the bricks are laid as shown by dotted lines in Fig. 37, that is, the stretcher on the external face and the two headers exactly behind them, covering the same length of space along the wall as the stretcher, these bricks are then said to be laid in sectional bond, that is, the two ends of the stretcher compare with the two headers in an exact length of the wall, and the joints at the ends of the stretchers and headers run at right angles from the face of the work throughout the thickness or section of the wall.

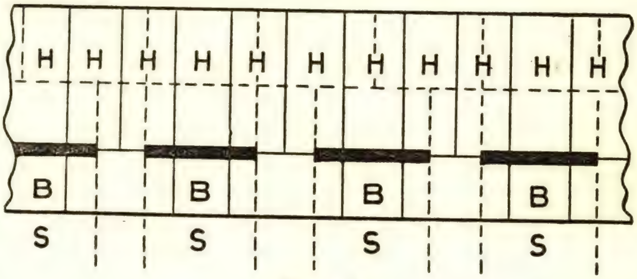


FIG. 38.

Applications of Flemish Bond.—Flemish bond shows a much weaker combination of joints in the interior of the wall.

Fig. 38 gives a plan of a one and a half brick wall in single Flemish bond. This is slightly stronger than double Flemish bond, there being not quite so many straight perpendicular joints in the interior of the wall. The face work shows Flemish bond, which some people think has a more pleasing effect than English bond. Personally I prefer English bond both for strength and appearance, for it looks quite as neat and as pleasing in effect as Flemish bond.

This is reinforced by English bond, which forms part of the wall, and shows on the internal face of the wall. Again, in Flemish bonds, the use of bats or half bricks, which are used internally in walls of various thickness, tends towards weakness.

In Fig. 38, the lines show one course of headers internally in English bond, and the face work Flemish bond. As will be seen, a stretcher and half brick marked as B are used alternately in this course to form the bond. The dotted lines in this figure show the stretchers marked S on the face of the wall. Thus in laying these stretchers on the course below, straight perpendicular joints are formed at the back joints of the bats or half bricks, and also on a portion of the back joints of the two stretchers on either side in the course below. This straight perpendicular internal joint at the back of each stretcher is shown by the thick lines indicated. This demonstrates the points of weakness and bad combination of internal joints in the single Flemish bond.

Fig. 39 is an illustration of a one and a half brick wall in double Flemish bond. In this case, Flemish bond is worked externally and internally on the face of the work. To work this bond, bats or half bricks are used in the middle third section of the wall marked X. The straight lines shown indicate the first course on face. Starting from left to right, we have stretcher and header alternately marked in plain lines. The back or internal face is marked H for headers and S for stretchers. This, then, represents course 1. The second course is represented by dotted lines which show on the face and are marked on the diagram, H for headers and S for stretchers. Thus the header in second course left hand side external face covers the stretcher centrally in No. 1 course, and the half middle section of the centre bat marked with cross, and also the half middle section of the internal face header. This header causes one perpendicular straight internal joint at the right hand back portion of the header. The position of this header is indicated by shaded lines. The headers on the internal face over the stretcher S, indicated in first course with dotted lines and shaded, cause the same straight internal joint at back as at the front headers in this course.

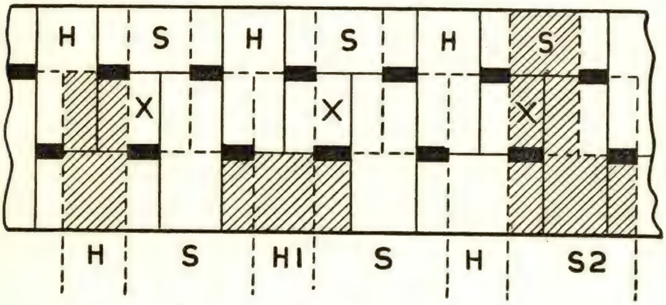


FIG. 39.

We will now take the stretchers in course 2, indicated by dotted lines on the internal and external face of work marked S on the external, and showing over the header marked H internally. The stretcher showing H1 on external course face and shaded represents the first course stretcher having the plain line all around it. The stretcher marked S2 on external face and shaded with dotted lines surrounding it is laid centrally over the header in course 1, and the straight joints in the internal part of the wall are at the back of this stretcher, marked with thick lines. This stretcher covers the 4½-inch portion of the header in No. 1 course, and also covers one-quarter of each stretcher at either side of the header in course 1.

Laying Old English Bond.—Having explained English and Flemish bond as regards the strength in English and the weakness in Flemish bond, we will now describe the various bonds that are used, starting with English bond. Fig. 40 is an illustration of the elevation of Old English bond. It comprises one course of headers and one course of stretchers alternately. This elevation gives the length of brickwork, and it will be noticed that to work this exact length, a closer has to be inserted at each end of the wall, to work the correct quarter bond. In the centre of the stretching course there is a header inserted. This cannot be avoided on account of the length of the wall, which in this case in the stretcher course amounts to six and a half stretchers. This bat or half brick breaks the correct bond in the wall, and is called broken bond. Another form of broken bond will be explained later in this chapter. This bat or half brick shown in the centre of the elevation is laid in every other course, this being the stretcher course, and follows up the entire height of the wall.

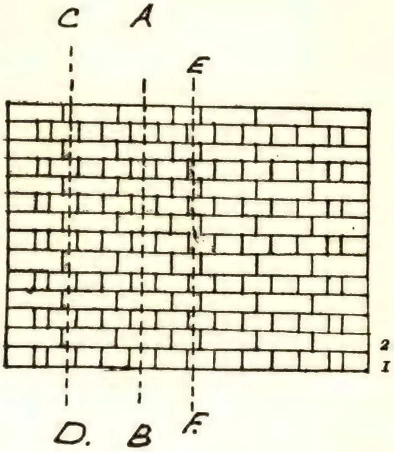
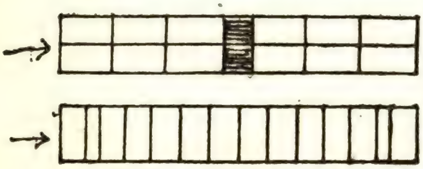


FIG. 40.



FIGS. 41 and 42.

Figs. 41 and 42 are the plans of the two courses, viz. header and stretcher. In the stretcher course, which is two half bricks wide, or one whole brick wide in thickness, stretchers are shown externally and internally on the face of the wall. This leaves a joint running through the centre of the wall longitudinally, except at the point where the header is placed in centre. The joints which form the cross joints at the ends of the stretcher bricks run from the external to the internal face. The heading course, which is shown in Fig. 42, gives all headers with the one queen closer next to the end header forming the bond. This heading course, when laid, completely covers the stretcher joints in the course below.

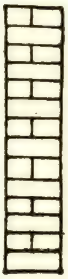


FIG. 43.

Fig. 43 gives an illustration of the end elevation of the wall. The stretcher which is shown at the bottom of this section represents No. 1 as shown in the elevation appearing as a header in the elevation. No. 2, the second course in the section, represents No. 2 in the elevation. No. 2 in section shows two headers, and No. 2 in the elevation shows one stretcher. In this case, we can only see one stretcher as shown in elevation, but when we go round to look at the end of the wall, we see the end of this stretcher which is one header, and also the end of the other stretcher which is behind the face stretcher. This shows as the second header; therefore in the end elevation we see the two headers as shown in No. 2 the second course.

Fig. 44 is the diagram of a section through the wall, at the point marked with dotted lines AB on the elevation, Fig. 40. The header, which is shown and marked 1 on the elevation at this point, appears a stretcher as shown in section AB marked 1, Fig. 45. The second course in section AB marked 2 shows two headers, and in the elevation the dotted line at the point marked 2 appears as a stretcher. So it will be seen, in a 9-inch wall, a header which shows on the face in elevation will show a stretcher in the section of the wall. This means that the stretcher face of the header is shown running from external to internal face of wall. In the case of the stretcher shown on elevation of a 9-inch wall, two headers will be shown as section of that wall. That is, the wall will be cut through, as it were, and the header face of the outside stretcher, and also the header face of the inside stretcher, will be shown; or the two ends of the stretchers which are laid one behind the other, the one external and the other internal.

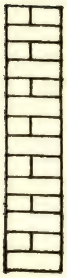


FIG. 44.

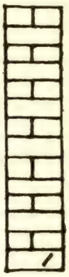


FIG. 45.

Section CD, Fig. 45, is the same as AB, the dotted lines being shown at different points on the elevation, but section appears the same. AB is practically in the centre of the stretcher in one course, and the header in the other. CD is at the end of the stretcher in one course, and near the middle of the header in the other course.

Fig. 46 which is an illustration of the section marked on elevation as EF. This is the point, as shown by dotted lines, where we have all headers showing on the top of the elevation. If the wall were cut through at this point, it would show all stretchers on the section as seen in Fig. 45.

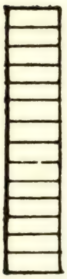


FIG. 46.

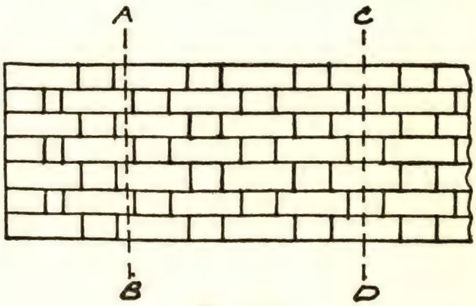


FIG. 47.

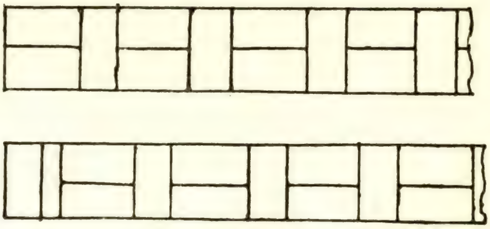
Laying the Flemish Bond.—We will now take the example of Flemish bond in a 9-inch wall, dealing with the elevation, plans, and sections in the same way as for English bond.

Fig. 47 is the elevation of a wall built in Flemish bond. I might mention here that double Flemish bond and single Flemish both show the same external elevation. Nine-inch walls cannot be built in single Flemish bond; they are usually built either in double Flemish or English. The least width of a wall that is usually built in single Flemish is the one and a half brick wall. Fig. 47 starts with the stretcher in No. 1 course and follows with the header and stretcher alternately. Course

No. 2 starts with the header, and next to this is the closer, which, as in the case of the English bond, is placed here to form the correct quarter bond. Next to this is the stretcher, which is laid centrally over the header in course 1. Next to this is the header, which is also laid centrally over the stretcher in course No. 1. They then follow stretcher, header, alternately along the course. No. 3 starts off again with the stretcher and so on, as in No. 1 course.

Fig. 48 is the plan of the first course marked on elevation No. 1, starting with the stretcher next the header and so on alternately. The headers in this case run from the external to internal face of wall. The back stretchers are then filled in between them to complete the course.

Fig. 49 is the plan of the second course marked on elevation, starting with the header. Next to it, the queen closer and then after this stretcher and header alternately to complete the course.


FIGS. 48 and 49.

Care must be taken, in Flemish bond, to ensure that the headers which run through the width of the wall should be all the same length. If this is not done, there will be bricks which are longer than the standard length projecting beyond the face of the internal wall, which looks very bad, especially if inside work has to be pointed.

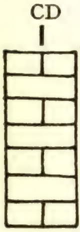


FIG. 50.

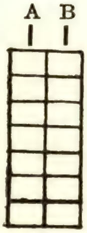


FIG. 51.

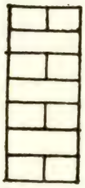


FIG. 52.

Fig. 50 is an illustration of section CD, which is shown by the dotted line on the elevation. The first course which the dotted line crosses is a stretcher in the elevation, which is two headers in the section marked CD. The second course at which the dotted line crosses is a header, and in section is shown as a stretcher. The dotted line runs exactly through the centre of the stretcher in the first course, and the centre of the header in the second course.

Fig. 51 is a section marked AB and shown on the elevation with dotted line, and also marked AB at each end of that line. This section of the wall runs through a point at the end almost of a stretcher in the first course, and the reverse end of a stretcher in the second course. Thus in section AB is shown a straight perpendicular joint in the interior of the wall, which is central between the stretchers in each course.

Fig. 52 is the end elevation of the wall, which is the same as if the wall were cut through at the point CD. The first course on elevation starts with a stretcher showing two headers in section ; second course header first brick on corner above the stretcher corner brick in first course, and shows a stretcher in second course of the section.

Fig. 53 is an illustration of the longitudinal section of one course of a 9-inch wall built in Flemish bond. This shows the length of the wall cut through the centre, showing the stretchers which are blocked in, and also the half bricks, or half the header marked H, showing the frogs to the half headers.

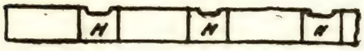


Fig. 53.

We will now pass on to the other bonds.

English Garden Wall Bond.—Fig. 54 is an illustration of the elevation of a wall built in English garden wall bond. This is generally 9 inches in thickness, and built for boundary or garden walls. This bond is really a variation of the Old English bond. Instead of having one course of headers and one course of stretchers alternately as in English bond, it has one course of headers and three courses of stretchers. In the elevation it will be noticed that the first course is a stretcher course. The second course starts with a header and the rest are stretchers following the header in the same course. The closer in the second course is omitted, instead of quarter bond as worked in English. These first three stretcher courses are worked half bond. The fourth course is the heading course starting with the header at the corner, the queen closer next to it, and headers following along in the same course. This course being worked in correct English bond, we get at the corner stretcher first course marked No. 1, header second course marked No. 2, stretcher at corner again in No. 3, and header and closer in No. 4 course. So the variation from the English bond is in the first three courses of stretchers, which are worked half bond instead of quarter, and the omittance of the closer, which could not be worked in this case in the second course.

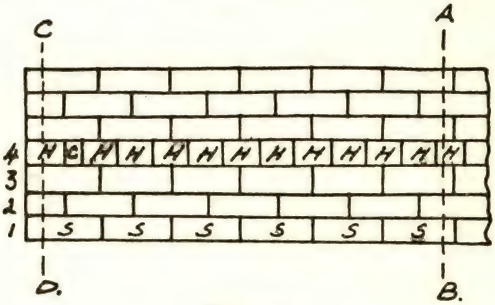


Fig. 54.

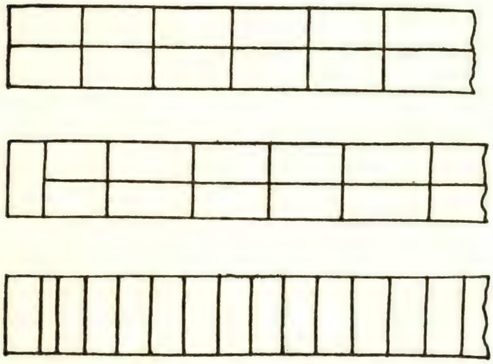

Figs. 55, 56, and 57.

Fig. 55 is the plan of the first and third courses of stretchers showing the front and back stretchers, making a 9-inch wall in width, starting with corner stretcher and continuing throughout the length of the wall.

Fig. 56 is the plan of the second course, which starts with the header and then follows with stretchers back and front throughout the length of the wall.

Fig. 57 is the plan of the fourth course which starts with a corner header, queen closer next to it, and follows on with headers throughout the length of the wall. So it will be seen that Nos. 1 and 3 courses are exactly alike, and Nos. 2 and 4 are different. These courses, Nos. 1, 2, 3, and 4, work alternately throughout the height of the wall.

Fig. 58 is an illustration of the section which is marked with dotted lines on the elevation AB. In the elevation, the first three courses are stretchers in which the dotted line AB cuts through, therefore at the backs of these stretchers and between them and the internal stretchers a straight vertical joint will occur in the centre of the wall. In the fourth course, the header shows on the face of the wall at the point in which dotted line AB passes. Therefore in section it will show as a stretcher. So we have in section AB first three courses showing straight perpendicular centre joint, stretcher showing in the fourth course, and straight perpendicular centre joint showing again in the fifth, sixth, and seventh courses. These show alternately, three and one throughout the height of the wall.

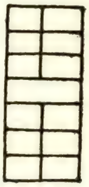


Fig. 58.—Section AB.

Fig. 59 is the section through the wall at the point shown with dotted lines on elevation CD. This section is near the corner, and shows on the elevation stretcher in the first course and header in the second course alternately throughout the height. Therefore in section the first course shows two headers, and the second course shows stretchers. This is alternate throughout the height at the dotted line CD. The end elevation will show exactly the same as section CD.

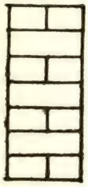


Fig. 59.—Section CD.

Flemish Garden Wall Bond.—Fig. 60 is an illustration of the elevation of a wall built in Flemish garden wall bond. In this type of the Flemish bond, the variation occurs in each course. Instead of one stretcher and one header alternately as in the case of Flemish, we get one header and three stretchers worked alternately along the length of each course, except at the starting from the corner brick. For instance, in the first course we have the header at the corner, queen closer next to it, and following three stretchers and one header worked alternately along the course. Then in the second course we have the stretcher at the corner, another stretcher following, which makes it two stretchers to start with on the second course. The header comes next, and then three stretchers

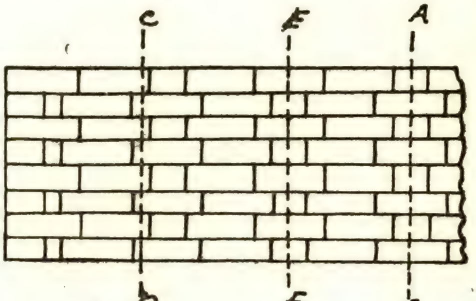


Fig. 60.

and one header are again worked alternately along the length of the course. The working of the two stretchers from the corner in the second course enables the header which comes next to them in this course to be placed centrally over the three stretchers which are in the course below or No. 1 course. So we see that the headers which are in every other course find themselves centrally each time between the centre of the three stretchers which are in the courses below and above them. In this instance, the first and second courses work alternately the same throughout the height of the wall.

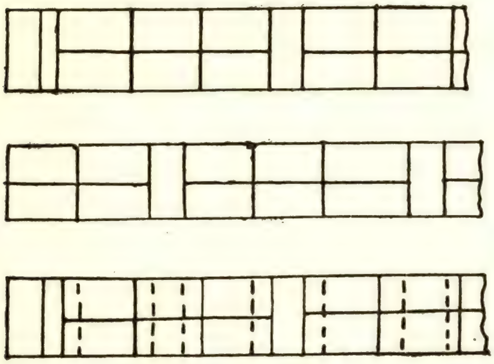

FIGS. 61, 62, and 63.

Fig. 61 is the plan of the first course, which is 9 inches in thickness, starting with the header, closer next, three stretchers and header alternately.

Fig. 62 is the plan of the second course, showing the two stretchers starting from the corner, then the header and three stretchers alternately throughout the length of wall.

Fig. 63 is the plan of the third course, which is a repetition of the first, with the addition of the dotted lines, which show the course above it, that is, the two stretchers starting from the corner and the header marked H and shaded, showing it in a central position over the three stretchers in the course below it.

Fig. 64 is section AB shown by dotted lines on elevation and marked AB. This section is cut through centrally at a point in the middle of the three stretchers in the one course, and the header over the central stretcher in the other course. First course in section AB shows a header, which is a stretcher in the elevation, and the second course in section AB shows a stretcher which shows a header in the elevation.

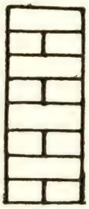


FIG. 64.—Section AB.

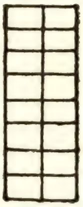


FIG. 65.—Section CD.

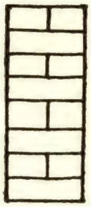


FIG. 66.—End Elevation.

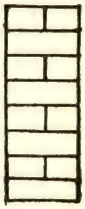


FIG. 67.—Section EF.

Fig. 65 shows section CD in which the dotted line at CD in elevation shows the point in which the wall is cut through. The dotted line is cut through all the stretchers in each course, therefore we have showing in this section a straight perpendicular centre joint at the back of all the face stretchers which show in the elevation.

Fig. 66 is the end elevation of this wall, No. 1 header on corner showing as stretcher on end elevation, and No. 2 stretcher on corner showing as header in section; three stretchers in end elevation and four headers alternately throughout the height of wall. Fig. 67 is the section through EF.

St. Andrew or English Cross Bond.—The next bond is called St. Andrew bond or English Cross bond. This is another variation of the Old English bond. It is used chiefly in the north of England. The first course displayed in the elevation of a wall built in this bond, Fig. 68, shows the heading course as in English bond. The second and third are also the same as in English bond. The fourth course varies, starting with the stretcher at the corner, but instead of continuing stretchers along the course, a header is placed next to it in this stretching course. Thus the variation from the English bond is in every fourth course, being the header worked next to the corner stretcher. This makes the stretching courses work half bond with each other, which means that the joints of the stretchers in No. 4 course work centrally over the stretchers in No. 2 course, or centrally between the stretcher joints in No. 2 course.

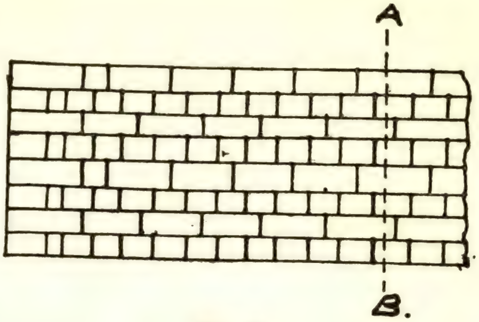
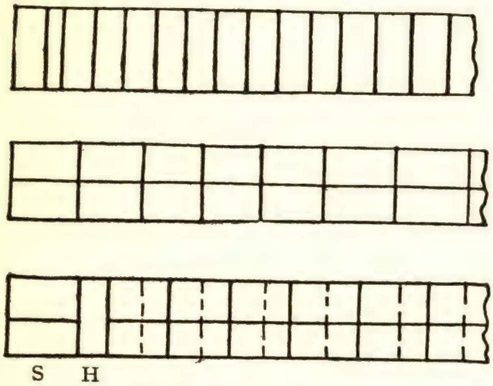


FIG. 68.



FIGS 69, 70, and 71.

Fig. 69 is the plan of the first course, which is 9 inches in thickness. This shows the heading course exactly the same as in English bond. Fig. 70 again shows the stretching course, which is also exactly the same as in the English bond. The plan of the fourth course shows the header next to the corner stretcher as in Fig. 71. The plain lines in this plan represent the fourth course, and the stretcher at the corner is marked S, the header next to it marked H. The dotted lines also show the course below, which is a stretcher course, containing all stretchers from the corner. This illustrates the half bond, the dotted lines being in the centre of the stretchers.

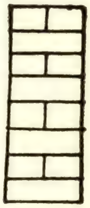


FIG. 72.

Fig. 72 is section AB. The point at which this section occurs is shown on elevation with dotted line marked AB. Starting from the bottom in elevation, it shows header and stretcher alternately in the height of wall. The section shows the bricks in the reverse position to this, that is to say, the stretcher and header alternately the whole height.

Fig. 73 shows the end elevation of the wall, which is exactly the same as in English bond.

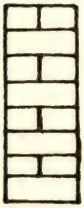


FIG. 73.

Mixed Garden Wall Bond.—The next bond, Fig. 74, is called Mixed Garden Wall bond. It contains courses of English bond, and also a course of Flemish bond. It is a very weak bond, being used only in garden walls, where there is not much strength required. It consists of three courses of stretchers built in half bond. The fourth course is built in Flemish bond, as shown in the elevation. The first course starts with a stretcher on the corner, also the third. The second starts with a header on the corner in order to work the half bond in the three stretching courses. The fourth course also starts with a header on the corner. Next to this is a three-quarter brick as marked with a cross in the elevation. Next to this is placed the header. After that is placed the stretcher and header alternately along the whole course, which forms the Flemish course in this mixed bond.

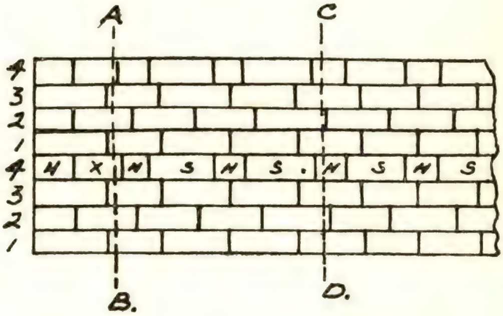
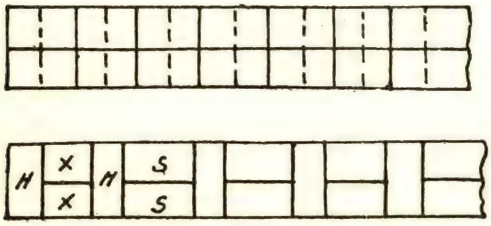


FIG. 74.

Fig. 75 is the plan and represents the first, second, and third courses composed of stretchers. The plain lines represent courses 1 and 3, which, as shown in elevation, start with a stretcher from the corner. No. 2 course starts with a header from the corner, as shown in elevation, but on the plan this course is shown by the dotted lines, which represent the second course being laid beneath the third.

Fig. 76 represents the plan of the fourth course, showing the Flemish bond course starting with header, three-quarters, and then header and stretcher alternately throughout the length of the course. This, of course, shows the bricks only along the face of wall. The plan, as we see it, contains header extending from external to internal face, two three-quarters, that is, the face three-quarter, and the three placed at the back of this, which forms the internal three-quarter. Then we have header from back to front, and two stretchers, one on face externally, and the other at the back of this, forming the internal face. This header and two stretchers, as explained, run alternately through the length of the wall, the header and stretchers placed as plan forming the width of the wall.



FIGS. 75 and 76.

Fig. 77 represents the section at the point at which the dotted line is shown on elevation marked AB. This line runs through the first, second, and third courses, which are stretchers. The fourth course is a three-quarter. The same thing occurs with the next four courses, which are a repetition of the first four. The stretchers and also the three-quarters, as shown on elevation, represent headers when shown on the section AB; therefore, again, at the back of these stretchers and three-quarters, there is a vertical joint, which is in the centre of the wall, after the internal stretchers and three-quarters are placed against it. Thus we have the representation of this joint, which is illustrated in the section AB.

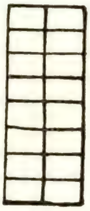


Fig. 77.—Section AB.

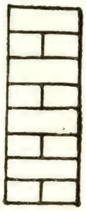


Fig. 78.—End Elevation.

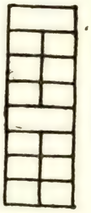


Fig. 79.—Section CD.

The end elevation starts in the first course with two headers, there being a stretcher shown on elevation, and a stretcher on the second in the end elevation, and so on throughout the height. This is represented in Fig. 78.

In Fig. 79 will be seen a section marked CD which occurs at a point marked on the elevation with dotted lines, also marked CD. In the first course the dotted line cuts through the end of a stretcher. In the second course, it cuts through the centre of a stretcher, and in the third course, it again cuts through the end of the stretcher. In cutting through these stretchers we again get three perpendicular centre joints as shown in section CD, marked 1, 2, and 3. The fourth course, as shown by dotted line in the elevation, is a header, therefore in section the fourth course will show a stretcher as marked 4 in section CD; while 1, 2, 3, and 4 courses, as shown in section, will run alternately throughout the height of the wall.

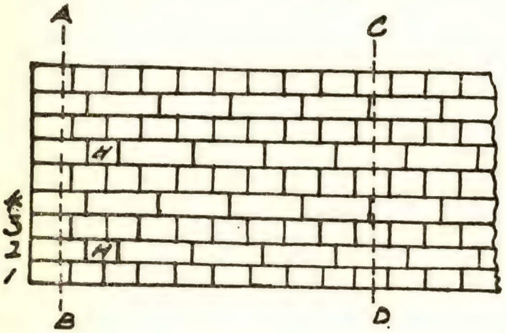
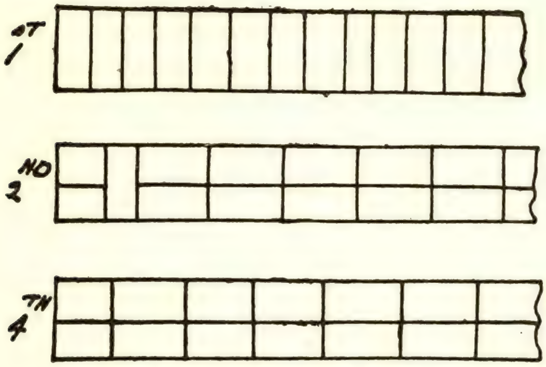


Fig. 80.

Dutch Bond.—Fig. 80 is the elevation of a wall built in Dutch bond. This is another variation of the English bond, which again proves that all the bonds used have originated either from the Old English bond or the Flemish bond. The first course in this elevation is practically the English bond heading course, with the exception that the closer is not used. The course is composed of all headers which follow along throughout the length of the course. The second course is the stretcher course. This starts with a three-quarter brick on the corner, followed by the header next to it, and then all stretchers follow the whole length of that course. So in this bond, there is a variation in both the header and the stretcher courses from the English bond. In the fourth course, the stretcher course starts on the corner with a three-quarter brick, and this is followed by stretchers all along the length of the wall in this course. In this fourth course, the three-quarter brick on the corner places the stretcher bricks 4½ inches farther along the wall than the stretchers in the second course, therefore this fourth course works half bond with the stretchers in the second course. The first, second, and third courses, that is, the header, stretcher, and header courses from the base of the wall upwards, work quarter bond as in English.



FIGS. 81, 82, and 83.

Fig. 81 represents the plan of Nos. 1 and 3 courses as marked on the elevation. The wall is 9 inches in thickness, and is composed of all headers throughout the course, the two starting from the corner and marked with an H to show this.

Fig. 82 is the plan of No. 2 course as shown on the elevation. This starts from the corner with a three-quarter brick, and next to it are stretchers continuing throughout the length of the course, being 9 inches in thickness. There is also a three-quarter brick at the back of the face three-quarter; also stretchers at the back of face stretchers.

Fig. 83 is the plan of the fourth course, as shown in elevation, starting from the corner with a three-quarter brick, header next, then continuing stretchers throughout the length of the course, as marked S on plan. The bricks which compose the 9-inch thickness of the wall are placed as in the other courses, behind the face bricks.

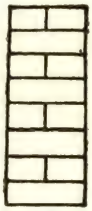


FIG. 84.—Section AB.

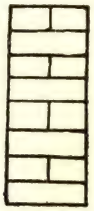


FIG. 85.—Section CD.

Fig. 84 is the section of the wall, shown by dotted line in the elevation marked AB, which shows, starting from the bottom upwards, header, three-quarter alternately throughout the height; therefore the section shows, starting from the bottom upwards, the reverse, which is, stretcher for the header in elevation, and two headers for the two three-quarter bricks in the elevation.

Fig. 85 is the section as marked on the elevation with dotted lines CD. This shows in elevation, starting at the bottom, header and stretcher alternately upwards throughout the height of the wall; therefore the section at CD will be for a 9-inch wall, stretcher first course, two headers second course, alternately throughout height of wall.

Stretching Bond.—Fig. 86 is an illustration of the elevation of what is known as stretching or stretcher bond. It consists of all stretchers for each course, except at every other course at the corner, where there is a bat or half brick inserted, so that the half bond is worked correctly, Fig. 87 showing a plan of the first course with the bat or half brick which starts the stretching course.

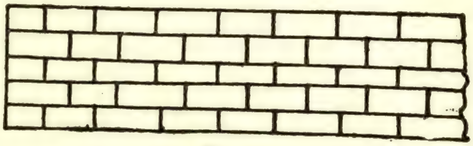
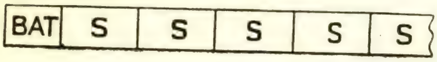


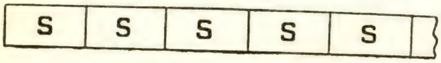
Fig. 86.

Fig. 88 illustrates the plan of the second course of stretchers in this course. The stretcher is placed on the corner, and all stretchers follow throughout the course. This bond is sometimes used for garden walls, or inside partitions. In the case of the garden wall built in this bond, it is usually reinforced with 9-inch piers at various intervals along the wall.



PLAN OF 1 COURSE.

Fig. 87.



PLAN OF 2 COURSE.

Fig. 88.

Ranging Bond.—Fig. 89 is the elevation of another kind of bond known as ranging bond. This is used in most cases for inside walls and partitions, where the work has to be rendered. It is built practically in English bond, with the exception of the closer and stretcher in the first and second courses. The first course in elevation consists of all headers, the second course consists of all stretchers, with the exception of the corner brick, which is a three-quarter. This enables the quarter bond to be worked. The third course, again, is worked with headers. In between every sixth course, a thin layer of wood is placed. This is for the purpose of attaching various fixtures. It also acts as a bonding strip for the brickwork. The walls are built sometimes in 9-inch work and others are built 4½ inches in thickness.

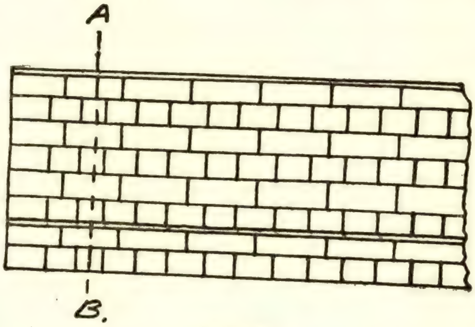
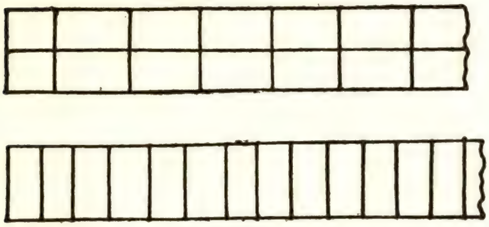


Fig. 89.

Fig. 90 illustrates the plan of the second course, which shows the three-quarter brick on the corner, and stretchers for the rest of the course. This is inserted in the stretching course when the fanal or pier or length of brickwork which has to be built works out an odd length, or an odd bat or half brick. This is a form of broken bond.

Fig. 91 shows the plan of the heading course, which is composed of all headers throughout the course. On this course should be laid the strip of wood as shown in Fig. 89. It is usually about ⅜ inch or less in thickness, and 4½ inches in width. It should be firmly bedded between the two courses on the side of the wall to which fixtures have to be attached.



FIGS. 90 and 91.

Figs. 92 and 93 are two sections through two walls of different thicknesses, one 9 inches thick, the other 4½ inches. The section of the 9-inch wall (Fig. 92) shows the wood running through the whole thickness of the wall, but in most cases it is only 4½ inches as stated before. This is the section of the wall through the dotted line AB shown on the elevation (Fig. 89). Headers at this point showing in each course, all stretchers are therefore shown on the section.

In the case of a 4½-inch wall built in this way, i.e. with wooden strips between every sixth course, the most satisfactory bond to use would be half bond, that is, with stretchers for each course (see Fig. 86). The reason for this is that if English bond were used, it would mean that there would be a large amount of bats or half bricks required for the heading course. This would be needless waste.

A circular or radius wall, which is built in heading bond, has a radius on the face of the brickwork. This enables only the width of the header brick to be worked within that radius, therefore, if the stretcher were used, the face of the brick being 9 inches instead of 4½ inches, it would require a much larger radius for it to come within the face work radius. As stated, these stretchers, which are longer on the face than the headers, require a much larger radius. They project at points on account of their length. These headers can be laid correctly on the face of a wall, and not project at any point if the circular or radius wall has a radius of 7 feet 6 inches. The first and second courses consist of headers in each course, each course working quarter bond with the other. When we have walls which have a smaller radius, viz. 7 feet 6 inches, we can still use the headers ; but they should be placed on their edge. Thus we have a smaller face surface, that is, 3 inches instead of 4½ inches. These can be worked in the same kind of bond as the 4½-inch headers, that is, half bond.

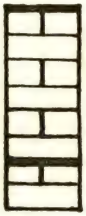


FIG. 92.

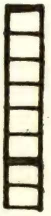


FIG. 93.

Paving Bond.—For this work the bricks are usually laid half bond, each course being 4½ inches in width, the first course starting with a half brick and then all stretchers following the length of the course; the second course comprises all stretchers, which works half bond with the first course.

In many cases the bricks are laid on their edge, measuring 3 inches each course. These bricks are also worked in half bond.

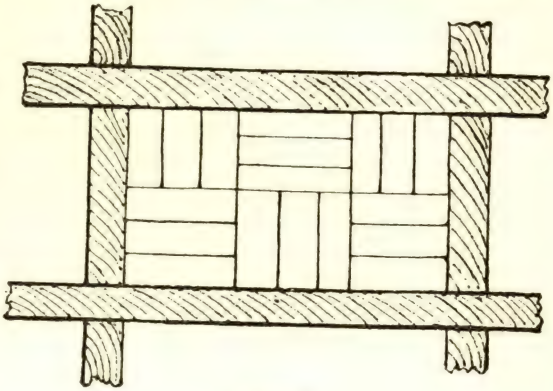


Fig. 94.

Diaper or Chequer Bond.—Fig. 94 is an illustration of what is called diaper bond. This bond is generally used for panelling, etc. The plan shows the diaper bond enclosed in wood framing forming small panels. It is generally 4½ inches in thickness and consists in the first course of the bricks being first worked on their ends, three of them practically forming a square 9 inches by 9 inches. The next three are worked flat, and the next three worked on their end again. The top course is the reverse to the bottom, so that when finished, this forms a series of squares, each containing three bricks, all worked the reverse to one another. This bond, when worked neatly, forms a very effective panel; or the same method can be applied to floors.

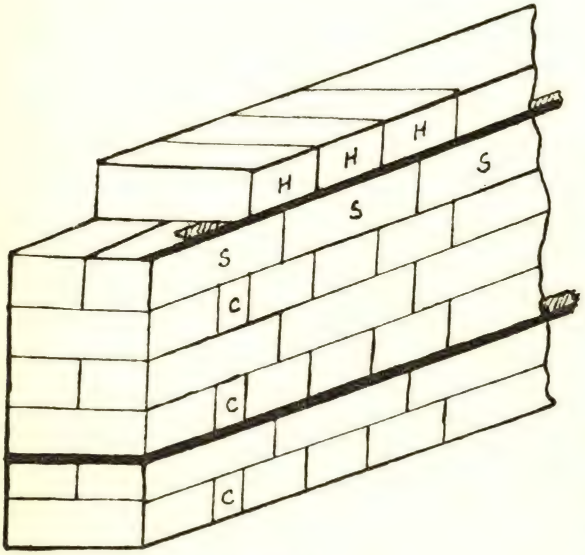


Fig. 95.

Fig. 95 is an illustration of an isometric view, showing the wood slips and the bond worked, which in this case is English bond. The wood in this case is only 2¼ inches in width as shown, where it is seen lying on the wall. All the bricks are marked, the closer marked C, stretchers under the wood slips or strips are marked S, and the headers marked H running from the face of the wall to the internal face, with a part of them lying on the wood strip. In this case there are four courses between the wood strips instead of six sometimes worked, according to position of various fixtures.

Zigzag Bond (Fig. 96).—This is an illustration of what is known as zigzag bond. It is a plan of a panel. This bond is also used for floors, etc. All bricks should be laid on their edge, that is, the 3-inch face of them should be showing. All the bricks should also be laid at an angle of 45 degrees. The best way to work this bond is to start by bedding No. 1 brick and placing it at an angle of 45 degrees, working the end of the brick to a perpendicular line, as dotted in illustration. No. 2 should then be placed against No. 1 in the opposite direction. The bottom corner of this brick should also touch the dotted upright line, and should be laid in the position of 45 degrees. These two bricks having been laid, they form a basis for the other bricks, which should then be laid parallel to each other, keeping to the dotted lines, and keeping in mind the exact position of 45 degrees. After all these have been laid to almost fill the panel, the pieces should be made up to fill the exact size of the panel. So the main points are to keep all bricks to the position of 45 degrees and parallel to each other and to work exactly to the horizontal and perpendicular dotted lines as shown in illustration.

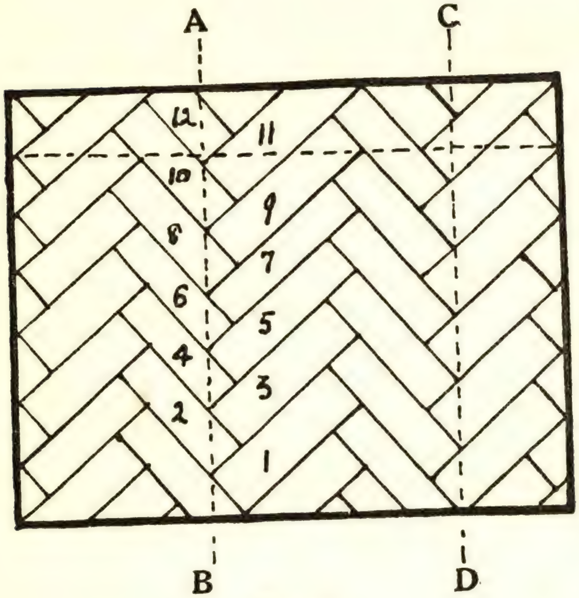


FIG. 96.

Diagonal Bond.—Figs. 97, 98, and 99 give the plan of a wall which is filled in with bricks laid at the angle of 45 degrees. This is called diagonal bond. This bond is generally used in thick walls. It does not show on the face of the wall, and forms a longitudinal bonding in the wall. The bonding is introduced about every sixth course, the

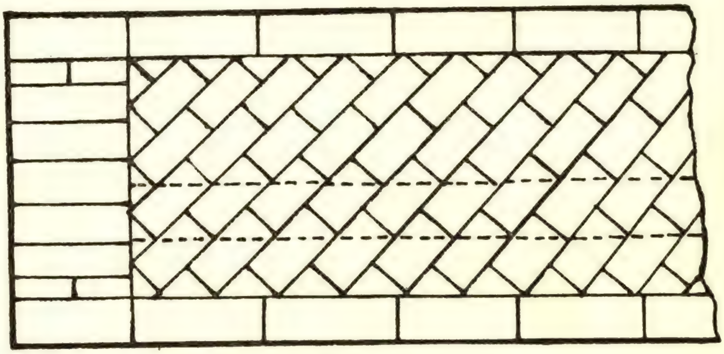
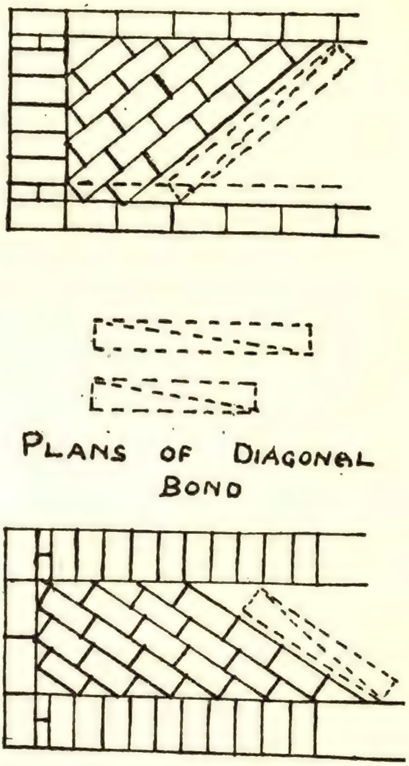


FIG. 97.

stretcher course forming the outside of wall, while the diagonal bond forms the interior. In this illustration it will be noticed that the outside bricks are stretchers, the headers forming the stop end of the wall. These bricks should be made up round the sides with small pieces of shaped bricks. In this illustration, the bricks are all laid flat, that is, the 4½-inch bed is shown in plan. These bricks, which are laid at the angle of 45 degrees, should be laid every sixth course, while the bricks laid in the sixth course will incline as shown in plan, left to right, in the twelfth course they should incline also at the angle of 45 degrees, but the reverse way, that is, right to left. By this method, a better combination of internal bond is obtained throughout the length and height of the wall. The outside portion of the sides of the wall is sometimes 9 inches in thickness, and sometimes the diagonal bond is bedded in the interior of the wall every fourth course instead of every sixth course.



FIGS. 98 and 99.

Herring-bone Bond.—Fig. 100 is an illustration of the plan of the bond called herring-bone bond. This is really a double diagonal bond, because that half of the interior of the wall in which the bond is placed runs from or inclines from the centre right to left, the centre line being shown by a dotted line. The other half of the bond inclines from left to right. In this bond, all the bricks should be laid at the angle of 45 degrees. The dotted line shows the centre line of the herring-bone bond.

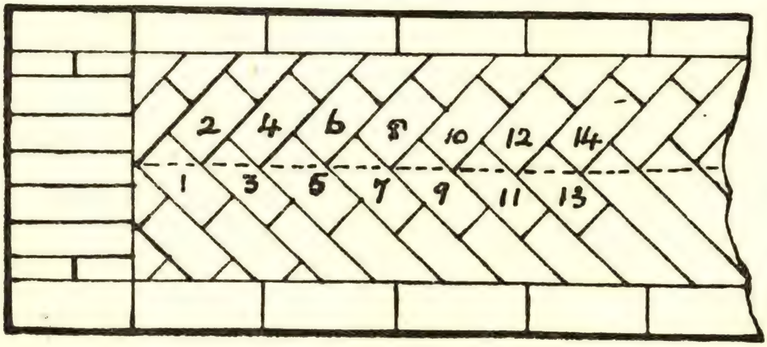
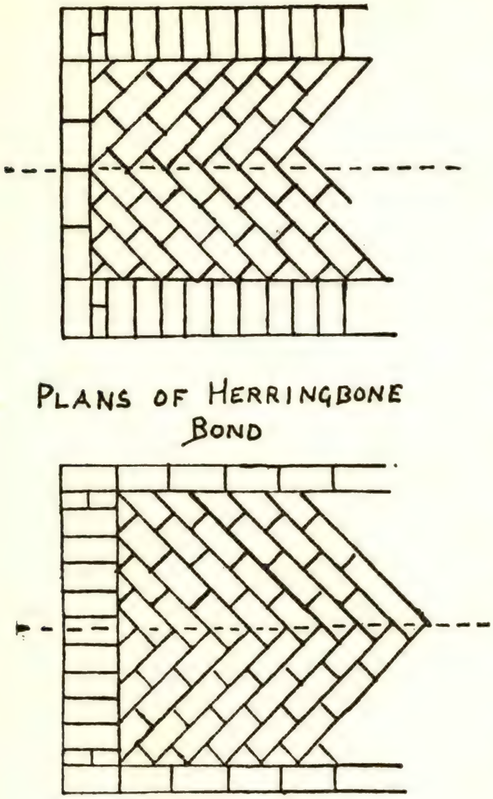


FIG. 100.

The ends of the bricks should touch this line at one corner. No. 1 should be laid first as shown, the corner touching the dotted line at the angle of 45 degrees, then No. 2 should be laid at the same angle. The corner of this brick also should touch the dotted line. Nos. 3 and 4 should be laid in the same manner, and so on right along the centre line of the interior of the wall. Next, the other bricks which are on either side of these should be laid, and the pieces made up towards the exterior bricks or stretching course, which forms the external and internal face of the wall. These courses can be reversed also at every fourth or sixth course.



FIGS. 101 and 102.

Herring-bone bond is used in panels, and is also used for flooring. In floors, the bricks are generally used the 3-inch way upwards, that is, the bricks are bedded on the edge, with the 4½-inch side of the brick forming the perpendicular joints between the bricks.

Figs. 101 and 102 are two plans of herring-bone bond showing one laid the reverse way to the other, also showing the 9-inch external walls instead of the 4½-inch on the side faces of the walls. Figs. 101 and 102 also show the diagonal bond laid the reverse way to each other, one from left to right, the other right to left incline. This bond is also laid in the interior of the wall, which has a 9-inch outside face and

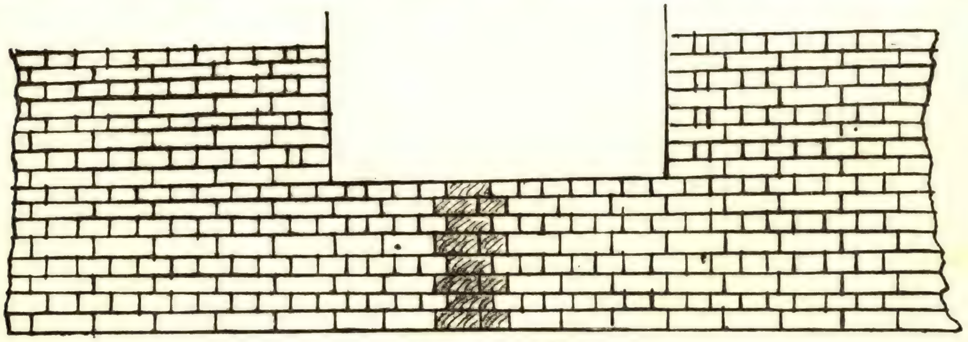


FIG. 103.

4½-inch end, and in the other it has a 4½-inch outside face and 9-inch at the end. Sometimes the outside walls are 9 inches in thickness when herring-bone bond is used in the interior of the wall.

Window Openings.—Fig. 103 is an illustration of a wall built in English bond, showing a window opening in the centre of the brickwork. This opening is an odd size, being six and a quarter bricks in width. This being so, six stretchers and a quarter are needed to fill this width. A quarter of a brick cannot be worked in the width to form the proper and correct English bond, so we must divide the one and a quarter bricks into two parts, and we get a three-quarter brick and a half brick or bat to fill this space. This is the correct bond to work to. This odd size over the five stretchers (that is, the one and a quarter bricks) is called broken bond. So in the stretching course we have a three-quarter and a half brick worked as near the centre of the opening as possible. In the heading course we get the three-quarter brick, the header finding its position next to it. Thus in the first course in the illustration we have the three-quarter and header worked to the left, and in the next course, which is a heading course, we have the three-quarter worked two and a quarter farther to the right along the course. Every other three-quarter brick in each alternate course is worked like this till we get to the top of the brickwork or the under side of the sill. The ends of the stretchers at either side of the opening come in a direct perpendicular line with the sides of the opening, therefore, when we come to the course in which the width of the opening is set out, these stretchers form the corner bricks at each side of the opening. So the stretcher forms the corner brick of the opening, and the closer is then placed next to it, in order to form the correct bond at each side of the opening. The correct broken bond in English bond is shown by the shaded lines in the elevation, which is the three-quarter brick and the half brick. In other words, in this instance the one course of headers and the one course of stretchers are broken. If we have a row of stretchers, as in the case of this opening, Fig. 103, it will be necessary to work the stretchers along the course each way to the centre of the opening. The space to be filled up is the length of one and a quarter bricks, therefore we use one three-quarter and one half brick to fill the space. These are both broken parts of the whole brick and different from the bond forming the stretching course, which is composed of whole bricks. It will be seen that the broken bond which is used in the stretching course is confined to two parts of the brick, that is, the three-quarter and the bat, which are different from the other bricks in the course. But in the heading course, the broken bond is confined to one part of a brick only, that is, the three-quarter, the half brick being the same as the other headers in this course.

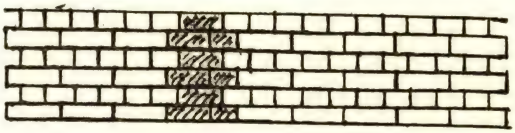


Fig. 104.

Fig. 104 is an illustration of a straight wall or pier where the broken bond appears the same as in the illustration which shows the opening with the broken bond.

Fig. 105 is an illustration of the correct method of forming broken bond in Flemish bonding, and each course contains header and stretcher alternately. The first course starting from the left towards the centre, we have 1, 2, 3, 4, 5, header, stretcher, header, stretcher, header. The same thing occurs if we start from right to left, 1, 2, 3, 4, 5, towards the centre. In the centre, the space to be filled in the first course as shown with shaded lines is equal to two stretchers or half a brick more than if the ordinary bond were running all through the course. In the second course, we have, starting from left to right, stretcher over No. 1 header, header over No. 2 stretcher, stretcher over No. 3 header, header over number 4 stretcher, and a stretcher over No. 5 header. The same thing occurs starting from right to left in the second course. But the space to be filled in this second course is one and a half bricks. So we place three headers over the two stretchers (as shaded) in the first course. This again is not the continuation of the correct Flemish bond throughout the course. The same remark applies to the stretching course in using the two stretchers, therefore, in Flemish, the correct broken bond is two stretchers in one course and three headers in the next course alternately. In the second course in the illustration, the broken bond is pushed towards the centre from each side a matter of 2¼ inches, which makes it one and a half bricks in width compared with the first course which is two bricks in width.

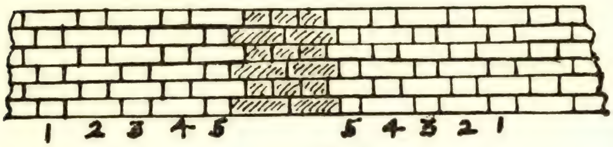


Fig. 105.

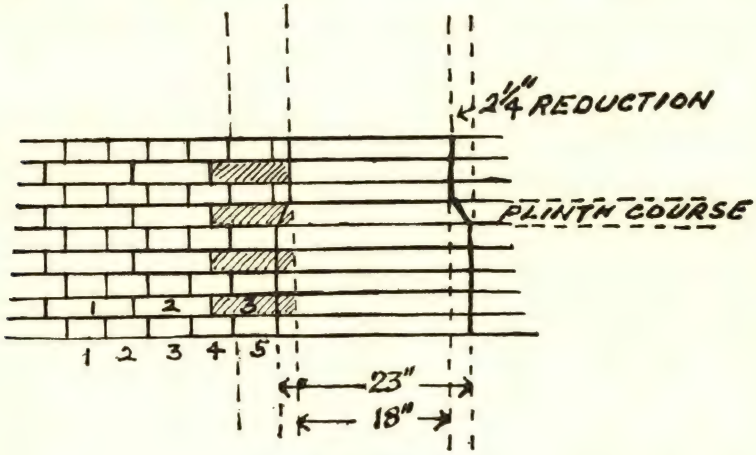


Fig. 106.

Fig. 106 is the elevation of a wall built in English bond with an 18-inch pier projecting 4½ inches from the face of the wall. The first course is composed of headers. Starting from No. 1 to 5, the fifth header comes in a line with the projection of the pier, which is shown by a straight line. The second course, which is a stretching course, is composed of stretchers numbered 1, 2, and 3. It will be noticed that the stretcher, which is shaded and marked No. 3, is extended 2¼ inches past the upright perpendicular line of the base of the pier, which is the widest part. The sixth course is set back with a plinth brick towards the face of the wall 2¼ inches. This stretcher being so placed, brings the end of the stretcher in a line with the stretcher in the eighth course. The eighth course shows the pier after being reduced 2¼ inches all round the face with the plinth brick. This is shown by the perpendicular lines at each side of the reduced part of the pier on top of the plinth course. The two perpendicular dotted lines on the right hand side of the pier show the two and a quarter reduction in the face size of the pier, which is from two and a half bricks to two bricks in width.

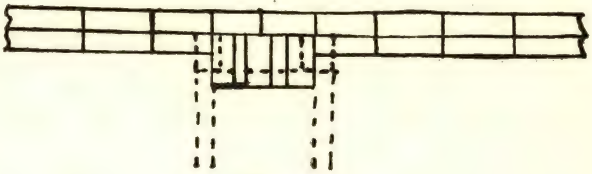


FIG. 107.

Fig. 107 illustrates the plan of the wall, with the pier projecting, showing the stretching course at each side of the 18-inch pier, as marked on plain lines, which indicate the reduced pier after the plinth course has been placed in position. The dotted lines show the 23-inch base before the 4½-inch reduction has been made.

There are various other so-called bonds, or the various placing of bricks such as in manholes, etc., where the bricks are laid in such a way so as to prevent the water getting through the horizontal bed joints, etc., but I will deal with these particular points when we come to the chapter on sanitary work. The subject is also discussed in the next two chapters and in that on decorative brickwork.

Lately the Monk bond has come into use. It is a blend of the Flemish bond and the Flemish garden wall bond, there being two stretchers to each header in the same course, the header being placed centrally over the joint dividing the two stretchers. This gives a zig-zag pattern on the face.

Another innovation introduced by Sir John Burnet, Tait & Lorne, Architects, is the use of large (9 inches by 6¾ inches by 2 inches) purpose-made bricks as quoins, to avoid the use of closers.

CHAPTER VII

FOUNDATIONS AND FOOTINGS

Testing Natural Foundations—Types of Natural Foundations—Datum Level—Building Lines—Levelling—Trenching—Templates—Trench Excavation—Strutting—Use of Boning Rod—Footings—Grillage Foundations—Pile Foundations—Raft Foundations—Tunnelling—Bricks and Mortars for Foundations.

FOUNDATIONS, of course, form a very important factor in building. Strictly speaking there are two distinct meanings. First there is the question of the natural foundation, that is to say a sufficiently solid soil to bear the building. Secondly, there are the walls and their footings, below the ground level, which support the upper walls and the whole edifice. The character of the footings and underground walls will necessarily depend as much upon the nature of the soil as upon the building itself.

Testing Natural Foundations.—The first proceeding before actually starting building operations is the clearing of the site. After this has been done, trial holes are usually dug at various points on the site to determine the nature of the ground on which the building is to be erected. These trial holes are generally in the form of a square hole about 4 feet in width, and vary in depth according to the nature of the soil. A trial hole, say from 6 feet to 10 feet in depth, should not be less than 4 feet square; this enables the navvy to work in the hole comfortably, but more space is often required. In some instances a depth of 2 or 3 feet only need be dug before striking a good foundation. In others, where there is very bad soil, it may require a much greater depth before a foundation is obtained.

Types of Natural Foundations.—Solid rock forms a very good foundation on which to build and will stand a pressure of a good many tons on the square foot. If, however, rock is badly fissured or broken up, or has a pronounced dip or slope, it will prove dissatisfactory, or at least call for special measures to render it safe. Sand or gravel also forms excellent foundations, provided the material is compact and free from water to any great extent. London blue clay and chalk form quite a sound foundation. But again, in both cases, the material should be solid and compact. Clay should also be reasonably dry, for it becomes dangerous if water gets access to it. In some cases drainage may become necessary, and is, indeed, insisted upon by the Local Sanitary Authority under certain conditions. The two materials just mentioned will stand a pressure of about 4 tons per square foot. Confined sand or ordinary clay will stand a pressure of about 2 tons per square foot. Sometimes a softer clay than the London blue clay is excavated, this will stand a pressure of about 1 ton per square foot. On all these materials, water and atmospheric conditions play a great part. In the case of clay, if the clay is compact and at a good depth below the surface of the site, so that it cannot be affected by the atmosphere, it makes a good, strong, solid foundation; but if it is near the surface and affected by the atmosphere, it has a tendency to crack and crumble, and is therefore very dangerous to build upon. This is seen at times when the trenches are exposed to rain and frost. The rain soaks into the surface of the clay; the frost freezes the clay surface, resulting in cracks and afterwards the crumbling of the clay. The frozen water expands and separates the particles which form the clay; this brings about this crumbling effect. Clay in this condition is very dangerous and treacherous. Clay also contracts when affected by the atmosphere, especially if exposed to the sun for any length of time during hot weather.

As already mentioned, even in rock foundations, fissures and cracks are sometimes found. These should be carefully examined, as they would probably cause bad defects in a building at some future period.

Datum Level.—Having found a suitable foundation upon which to start building, the next proceeding is to fix a datum level upon the site, in a suitable permanent place where it will not be disturbed during the process of the work. The datum level is a level which is generally marked on a wall of an adjacent old building; if there are no buildings it may consist of a stout peg driven in the ground in a convenient place where it will be safe from disturbance. This peg is usually surrounded with concrete to secure it in a firm position. The datum line, mark or peg is generally fixed by the surveyor, engineer or architect on a large site in preparation for building.

All levels which are required for the foundations, such as the bottom of the trenches, surface of the concrete, etc., are taken from this datum level.

Building Lines.—After the proper depths of the trenches have been determined, the next proceeding is to find their various positions, which are taken from the plans of the building. The building line is then determined. This line generally forms the position for the front elevation of the building, and in streets, lanes, etc., in towns or villages, or along main roads, in most cases it has to be an exact measurement from a point which is laid down by the Local Authority's surveyor In some cases this measurement is taken from the centre line of roadway, or it may be a line or mark defined on the edge of the pavement curbing. This building line must be taken accurately. If the buildings on either side of the proposed building are very old and dilapidated, or if in certain cases the road is narrow and there is a tremendous amount of traffic passing, it may mean that under such circumstances the Local Authority may have an improvement scheme in progress for widening the road,

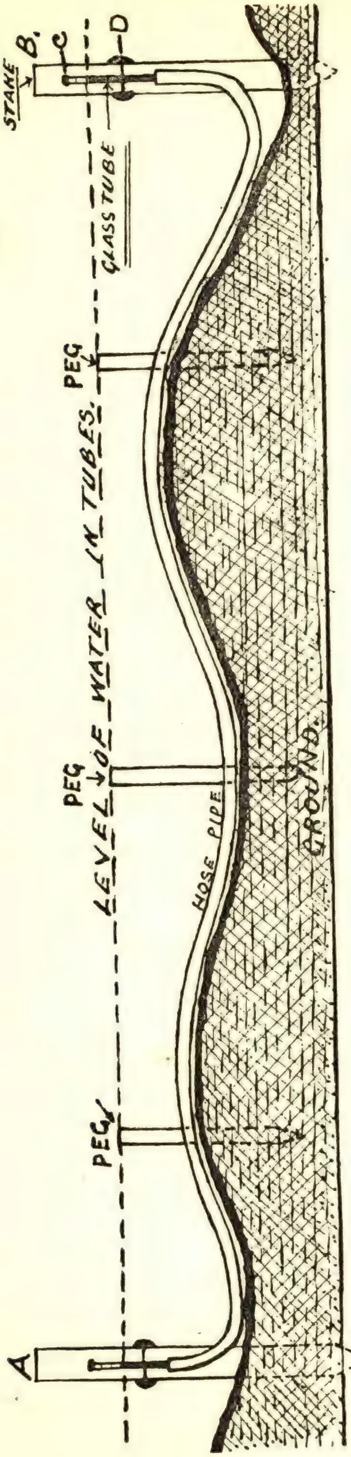


Fig. 109.

and as old existing buildings are being pulled down, or their leases run out, they may require a new frontage line. That is to say, a new position will be required for the proposed building and all future buildings in the street or road. The frontage line of the proposed building would then be pushed back to the required distance from the centre of the road, and as the other buildings were demolished from time to time, the buildings proposed in their place would also have to take the new frontage line. In this way, after a number of years a new frontage line to all the new buildings along the road would be established. The point is that if a building line has been fixed by a Local Authority and this is overstepped it would entail rectifying even to the extent of demolition of a building.

The next proceeding is to determine the various widths and depths of the trenches to be excavated and their exact positions. But before starting the actual excavation of the trenches the site should be reasonably levelled off. There will be a great advantage in doing this, because if there is a considerable amount of earth to be removed from the trenches, it will be easier to convey on planks placed on level ground than running the plank runs over uneven ground.

Levelling.—Fig. 109 is an illustration of an uneven piece of ground on which will be required one level marked A and one level marked B at different ends of the site. These two levels are to be exactly the same. An easy way of obtaining these levels is by the use of a long hose pipe and a glass tube inserted at each end of it, after it has been filled with water. First drive into the ground a large wooden stake about 2 inches by 2 inches, marked A. This will be the datum peg, and all the others can be taken from it. This peg should be about 3 feet in length or perhaps longer, according to the different heights of the uneven surface of the ground. It should be securely fixed into the ground and concreted in to keep it in a firm upright position. Having fixed stake A we then proceed to fix stake B at the position where it is required at the opposite end of site. This stake should also be fixed firmly in an upright position, allowing plenty of height above the ground. It should be 12 inches at least above the highest point of ground. Having fixed these two pegs, the length of hose pipe should be filled with water and sealed with a cap marked C. Care should be taken to fill the hose properly and to leave no air pockets. It should be filled to within 2 inches for allowance of air space. The hose pipe should be taken to stake A and fixed to it by the bracket which is marked D. This holds the glass at end of tube, which has a numbered gauge of inches on it, in a perpendicular position against the stake. This having been done the hose pipe is taken along to peg or stake at B, after the level has been found by sliding the glass tube which is inserted in the end of hose up and down, until it indicates the same gauge as the one at stake A. The gauge mark should be marked on both stakes. Then, as will be seen, the level of the water will be the same in tube at stake A as that in tube at stake B. This, of course, is a method that could be used either on a large or a small site, but under ordinary circumstances the engineer or surveyor generally obtains the site levels by using the dumpy or theodolite levels.

The intermediate pegs as shown in this illustration can be obtained by levelling from the datum peg, or if it is a very small site, by straining a line from the exact gauge mark on one peg to the other. These can be checked by the long level and straightedge afterwards. If the line was used, the tops of the intermediate pegs would just touch the bottom of the line. A small allowance would have to be made for the sag or drop of the line, therefore it would be best to check them with the long level afterwards from the datum peg.

Having determined the levels of the site from the datum line or peg, and having the frontage line of the building also fixed, the centre point of the front line is next fixed and a line from it is pegged out. All the walls, that is the flank walls and intersecting walls, are set out from the line of the front walls by the use of squares and wall templates, the distances of the walls which are at right angles to the front walls being taken from the centre line. The centre lines of all walls should be worked to these lines, and should be taken from the plans and fixed to a template board. These lines should be defined by saw cuts, as these are not easily obliterated.

Trenching.—Fig. 110 is an illustration of the trench showing the wall template fixed into position by means of two upright pegs, which are inserted into two drain pipes. These are filled with earth to keep the upright pegs in a firm position. In this case they are about 9 inches on either side of the trench lines.

Templates.—In some cases a template is fixed to two stakes driven into the ground at either side of the trench. This method is more secure than the one shown in Fig. 110, in which the pegs are placed and fixed into the drain because there is a possibility of the pipes getting broken or moved out of their original position. These templates, besides serving the purpose of defining the various widths of the walls, concrete, and trench lines, can be placed in such a position as to define the levels at the bottom of the trenches. These horizontal

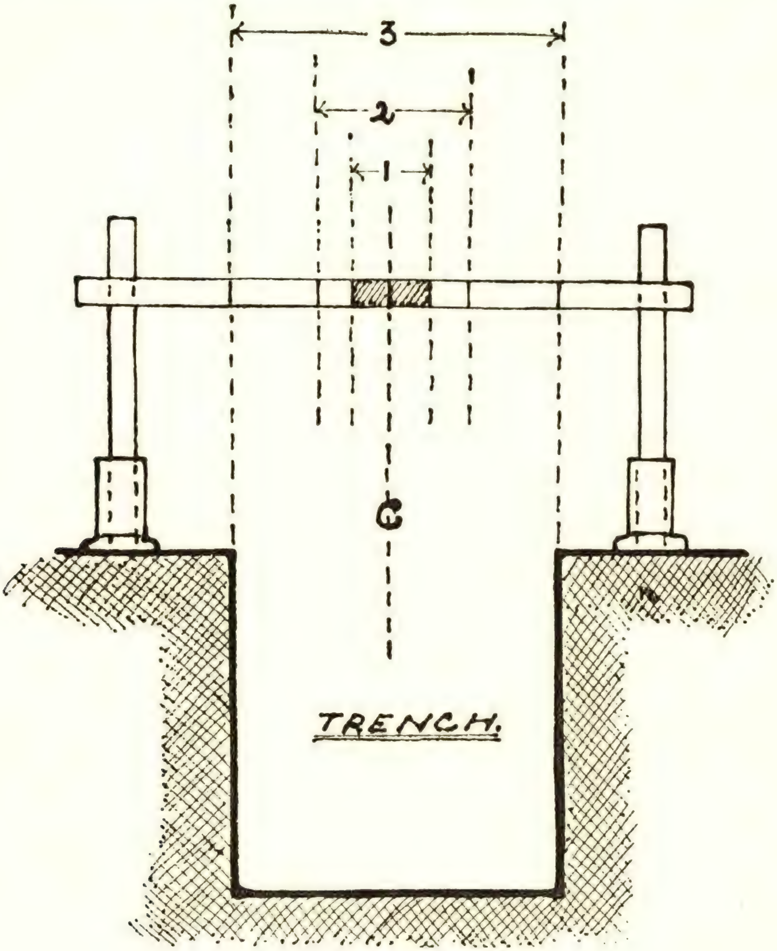


Fig. 110.

templates can be also used as sight rails from one position to another along the trenches. For instance, take Fig. 110 as being the template at one end of a trench. This horizontal template should be levelled exactly as to its position from the datum line or peg. The template itself should also be in a true horizontal position from end to end.

With this template in position it is easy to define an exact position as to a point to be fixed for the bottom of the trench by taking a certain measurement from the under side of the template to the bottom of the trench. Having done this it is then possible to fix another template at the other end of trench; fixing this one also at exactly the same level as the first. These being now in position at either end of the trench they can be used as sight rails from one end of the trench to the other. This is done by sighting them from the top line of the horizontal template at one end of the trench to the other. A small rod could be used for the purpose of defining the points for the bottom of the trench intermediate between the two sight rails. This rod should be marked in inches, and the pointed end of it should be driven in the clay until the exact depth from the sight line to the bottom of the trench is defined on the rod. Say, for instance, the distance is 5 feet at each end from the sight rail to the bottom of trench, then this distance on the rod would have to be 5 feet from the sight line to the bottom of trench. Of course, we are assuming that the trench has been dug out and a rough bottom attained. If the 5-feet mark shown on the rod penetrates the ground, say for about 6 inches, then it follows that this depth of clay has to be taken off the bottom of the trench in order to obtain the correct distance from sight line to bottom of trench, which is 5 feet.

Sometimes another method is used. Having placed in position and levelled in horizontally from the datum, a certain distance is taken from the bottom template to a point which defines the bottom of trench. A peg is then driven in to fix this position and from this peg all the other pegs along the various trenches are levelled as the trenches are excavated. The same method can be proceeded with in defining the surfaces and depths of the concrete.

Fig. 110 shows the horizontal template nailed into the two upright pegs. The dotted line marked C is the centre line from which the measurements of the other lines are taken. The shaded portion on template is the width of the 9-inch wall. This is continued up with dotted lines and marked No. 1. At either side of this are lines marked which denote the width of the footings on either side of the wall. These dotted lines are continued up and marked No. 2. Further extensions are marked with lines at either side of the widths of the footings. This is the width of the concrete at each side of the footings. These lines, besides giving the width of the concrete, also define the width of the trenches to be excavated. All the concrete lines which are marked on the template are obtained from the plans, taken from a centre position from all the walls, which vary, of course, in width. The width of the footings and concrete is taken from the various sections of the walls and the depth of concrete for all walls is also taken from the sections.

In setting out these various intersecting walls, either from front to back, or from side to side, the square has to be used. This is called the "builders' square." This is usually made of pine, and about 6 feet long at each side. A brace piece holds these two sides together; this is fixed half-way along the length of the sides at an angle of 45 degrees. This should be made exactly square, and can be tested by the measurements in equal ratio to those shown below the illustration, that is 8 feet along one side, 6 feet along the other side, and these two measurements when measured at their extreme points should be 10 feet exactly. Or another ratio for a smaller square 3 feet along one side, 4 feet along the other side, and the extreme point measurement should be 5 feet. The wood of which this square is made should be very substantial. The thickness should be about 1 inch or more and the width 4 inches.

Trench Excavation.—Having set out the pegs and fixed the templates in position the next proceeding is to excavate the trenches. If these are to be dug to any considerable depth (which depends upon the nature of the soil and the depth at which a good solid foundation is gained) the trenches should be strutted to prevent any of the ground falling into the trench after it has been excavated. The method of strutting used depends upon the nature of the ground at the sides of the trenches to be made secure.

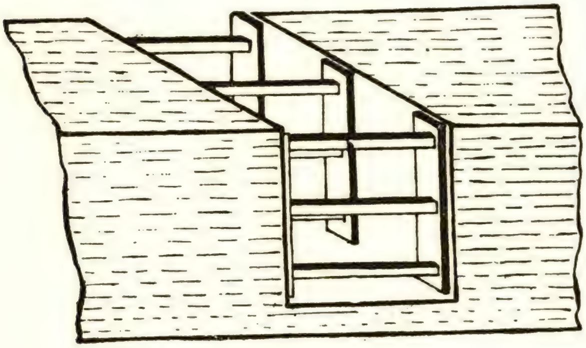


Fig. 111.

Strutting.—Fig. 111 is an illustration of the method which is used in strutting a trench of which the sides consist of firm solid ground. Poling boards and struts are used for the purpose. The poling board is usually about 1½ inches in thickness, 6 inches to 9 inches in width, and the ordinary length is 3 feet. They are sometimes used in longer lengths about 6 feet. The cross pieces or struts which hold the poling boards in position are usually about 4 inches by 3 inches or 4 inches by 4 inches. Sometimes short thick ends of scaffold poles are used for strutting. In this case the poling boards are strutted at horizontal lengths from 6 feet to 9 feet apart. This strutting is quite effective in good firm ground, such as the London blue clay.

Fig. 112 is another method of strutting trenches where the ground is loose. This consists of poling boards which are placed along the side of the trench in a perpendicular position close against one another. A wailing piece is placed against these in a horizontal position, one piece close to the top of the poling boards, the other piece at the bottom. This wailing piece consists of a piece of timber 12 feet in length, and usually about 6 inches by 3 inches or 6 inches by 4 inches. These wailing pieces are held in position by the struts, which are 4 inches by 4 inches, as in the first case. The poling boards being placed very close to each other hold the ground in a compact condition at the back of the boards.

Fig. 113 is an illustration of another form of strutting for loose ground.

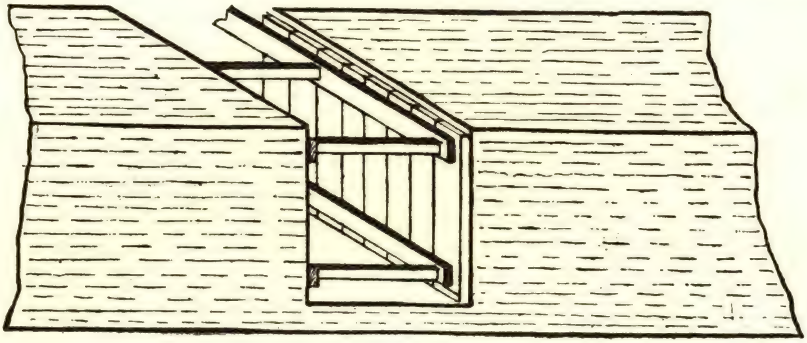


Fig. 112.

Long boards are placed in a horizontal position against the side of the trench as numbered 1, 2, 3, 4, and 5. These boards are 9 inches by 1½ inches and 12 feet in length. This method of placing the boards is called sheeting. The poling boards are placed against these in a perpendicular position about 6 feet apart. The struts are then placed in position in between these poling boards. In some trenches where

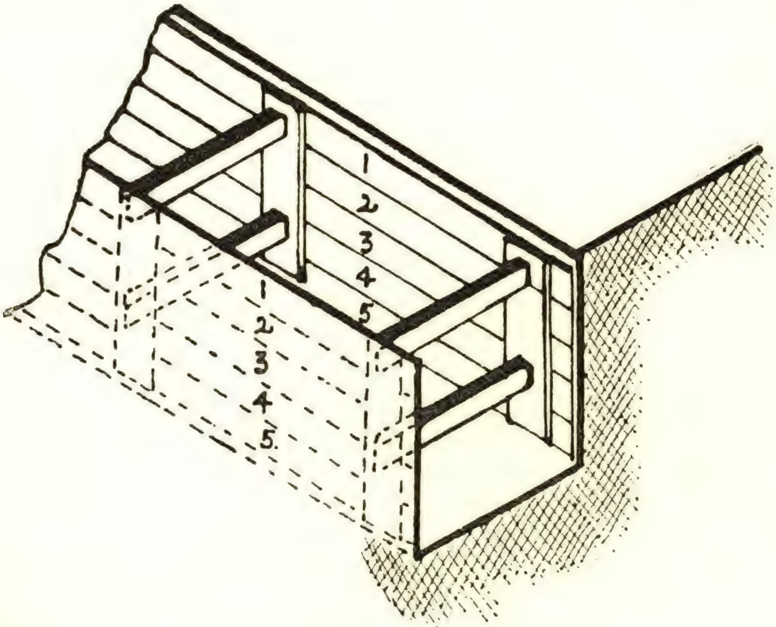


Fig. 113.

there is loose ground the sides are sloped. In this case there would be a lesser width at the bottom than at the top of the trench, therefore the struts would be shorter at the bottom than at the top.

Fig. 114 shows a method of strutting when the ground is moderately good; by this is meant not a firm ground and yet not a loose ground—just the medium between the two. This method consists of placing a series of poling boards about 6 inches apart along the side of the trench. A wailing piece is placed against these poling boards in a horizontal position in the centre of the boards. These are held in position by the struts, which are placed in a horizontal position between the two wailings, which should be about 6 feet apart.

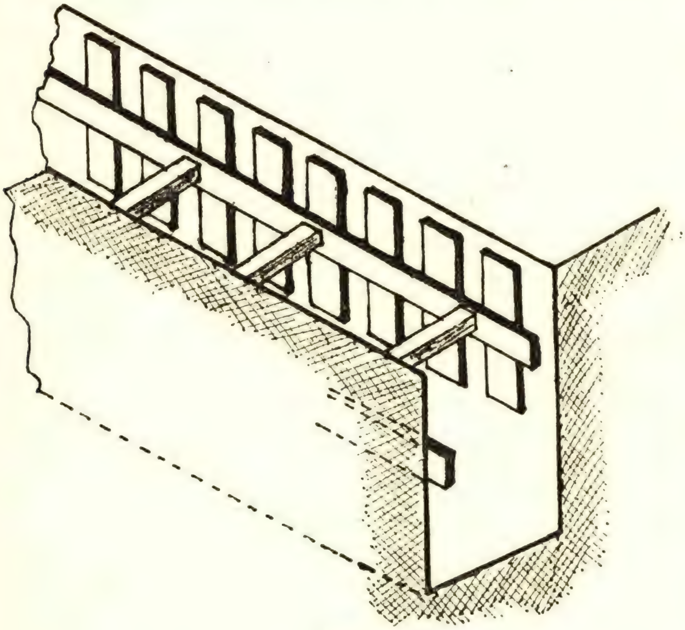


FIG. 114.

Use of Boning Rod.—Fig. 115 is an illustration of the boning rod method used for levelling trenches. In this method a set of three rods are used which are T-shaped, as shown in illustration. Rod B is placed in position and the bottom end of it rests on the bottom of the trench. A mark is made on it which should be level with the peg, say 6 inches above the bottom of the trench; the position of rod A is then found and the mark on it would be 6 inches above the bottom of trench. This is the top of the peg A. Sometimes the rod B is placed on top of the peg B, and the rod A placed on top of the peg A. This gives the same result in each case. Rods A and B can be placed 12 feet to 20 feet apart along the trench. The centre rod should then be placed at various intermediate positions between the rods A and B and sighted through. The sight line is shown at the top of rod B with a line terminating with arrow at each end. By this method the pegs can be fixed in the intermediate positions along the trench as marked in circles (1), (2), (3), (4), and (5); after this has been done, another length can be proceeded with on the same lines.

Footings.—Footings are the base part of the built-up foundations when these are widened beyond the breadth of the walls. The footings may be in the form of a platform, but more commonly are constructed as a series of off-sets or steps, thus causing the foundations to splay out to counteract lateral spreading from vertical thrust.

We will now proceed to consider the various plans and sections of footings as required for the various thicknesses of walls.

Fig. 116 shows the section of a 9-inch wall, with the footings and the thickness of the concrete under them. These footings, or bottom courses of a wall, should project 2¼ inches in each course, beyond the external face of the wall, and also beyond the internal face of the wall. As stated, these courses are built for the purpose of distributing the weight of the wall over a large area of the foundation. The number of courses of footings vary according to the different thicknesses of the walls which are placed over them, the height of the building, and the character of the soil. The thicker and taller the wall, the larger should be the number of courses of footings. Obviously, the weight of the wall would be much greater in an 18-inch wall than in a 9-inch one, therefore the area of weight distribution in the 18-inch wall would be much larger. The 9-inch wall in Fig. 116 contains two courses of footings. They project in the two courses 4½ inches each side of the wall. This makes the bottom course of footings 18 inches in width, or twice the thickness of the 9-inch wall. This rule applies to all the wall that is, the bottom course of footings should not be less than twice the thickness of the wall in width, but may have to be more.

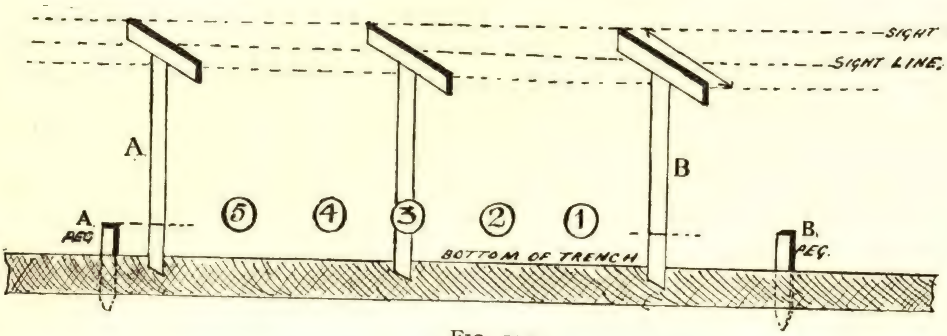


FIG. 115.

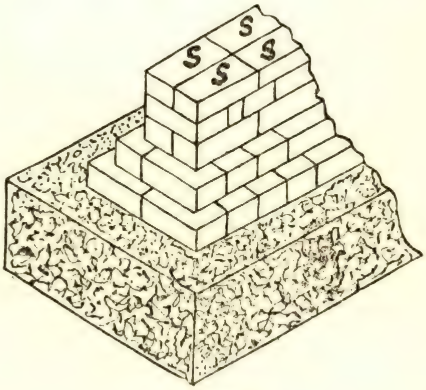


FIG. 116.

The concrete for this wall as shown in illustration is 12 inches thick. The London County Council make provisions for the least thickness of concrete that should be put under a 9-inch wall, and in their by-law it states that for a 9-inch wall it should not be less than 9 inches in thickness, and the concrete shall also project 4 inches on either side of the lowest course of footings. This thickness of concrete applies principally to house building in the London Area and within the London County Council jurisdiction.

The concrete used should be good concrete where large buildings are in question, with thick heavy walls. The widths and depths of the concrete foundations are usually determined by the nature of the ground upon which they are built, or by the bearing strength of the ground. The pressures of foundations upon natural ground are given by the London County Council (General Powers) Act, 1909, in clauses 24 and 25. It is there stated that they shall not exceed 1 ton per square foot upon a natural bed of soft clay or wet sand, 2 tons upon a natural bed of ordinary clay or confined sand, and 4 tons upon a natural bed of London blue clay, compact gravel, or chalk. And the pressure on concrete foundations shall not exceed 12 tons per square foot. The London County Council regulations now place the maximum safe load upon natural ground at from 1 to 4 tons per superficial foot. The depth of concrete to be used for various walls is usually a matter of experience according to the various natures of the different soils upon which the walls are to be built.

Fig. 117 also includes a plan of the 9-inch wall, showing footings and concrete marked 1. The first course of footings to the 9-inch wall is 18 inches in width, or twice the thickness of the 9-inch wall. The second course of footings is marked No. 2. This course is one and a half bricks in thickness, or one and a half times the thickness of the 9-inch wall. No. 3 shows the 9-inch wall, or one brick in width. At each side of the first course of footings, as marked No. 1, can be seen the concrete extending at least 4 inches.

Fig. 118 shows the section of a 14-inch wall, or one and a half brick wall. This is also called the standard thickness wall, from which all measurements are taken when calculating brickwork quantities, as will be explained in a later chapter. This illustration shows the section of the footings and concrete, also the plan of same. Nos. 1, 2, and 3 as marked show the three courses of footings on one side of the wall. The same number of courses are shown at the other side. All these courses project 2¼ inches from the wall. No. 4 as marked shows the plan of the 14-inch wall, headers one side or 9 inches of the wall, and stretchers the other side, which is 4½ inches of the wall. The ½ inch is generally allowed for the wall joint between the stretchers on one side of wall and headers on the other side. The concrete is shown on either side of the first course of footings. This extends at least 4 inches. The section in the 14-inch wall, or one and a half brick wall, shows the depth of concrete; in this case it is 18 inches. Three courses of footings are marked 1, 2, 3, No. 1 three bricks wide or twice the thickness of the wall, which is one and a half bricks in thickness. Above these courses of footings is the wall, stretcher on one side and header the other alternately in each course.

Fig. 119 shows the plan and section of the two-brick or 18-inch wall. It will be noticed in the section in this case there are four courses of footings as numbered 1, 2, 3, 4. The bottom and widest course is four bricks in width, or twice the thickness of the wall, which is two bricks wide. The first course of footings contains four stretchers in section.

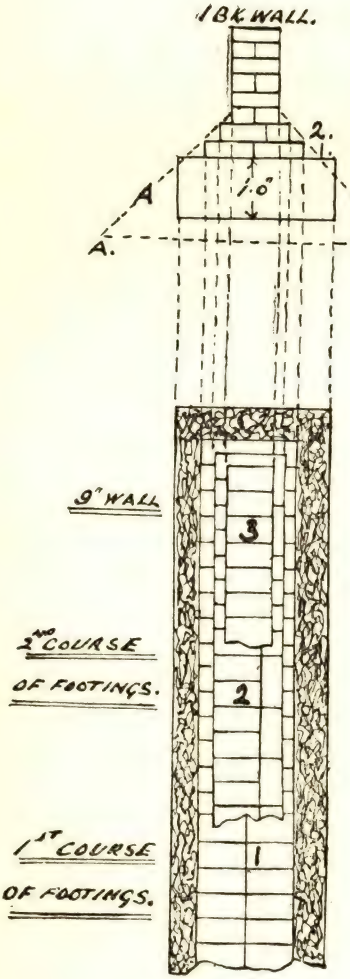


FIG. 117.

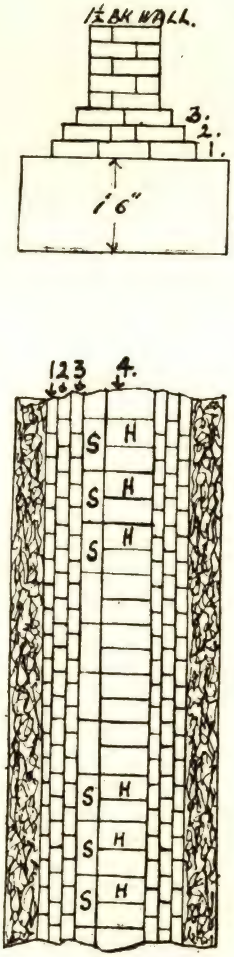


FIG. 118.

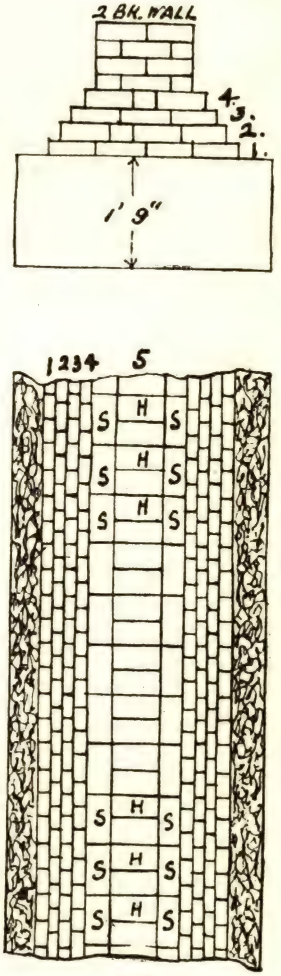


FIG. 119.

The second course three stretchers and one header. The third course three stretchers and the fourth course two stretchers and one header in centre. The concrete in this case is 1 foot 9 inches in depth, and the width is 6 inches more on either side of the lowest course of footings. In the plan the courses of footings are also shown on either side of the wall; the left hand courses of footings are numbered 1, 2, 3, and 4 The concrete is also shown at each side of the widest course of footings

The 18-inch wall is shown and the bond consists of a course of stretchers at either side of the wall, which makes 9 inches in width. The internal 9 inches is filled in with headers, laid in sectional bond. The next course would consist of a double row of headers all along the length of the wall.

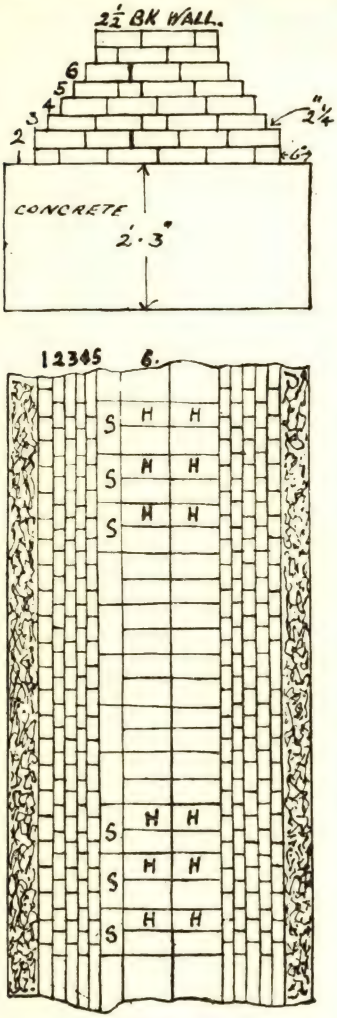


FIG. 120.

Fig. 120 is the section and plan of the two and a half brick wall. In this section it will be seen that there are six courses of footings, the first two courses being the same width. This is a double course of footings, and is built for strength. It will also be seen that these first two courses contain five bricks in width, or twice the width of the wall, which is two and a half bricks wide. The first course contains a stretcher course on the outsides of the wall and is filled in internally with four rows of headers throughout the length of the wall. The second course contains five rows of headers running the length of the wall. The outside headers in the second course cover the outside stretcher and half the internal header in the first course, making these two courses work half bond with each other. The third course contains four rows of headers and one row of stretchers throughout the length of wall. Of course all these courses showing stretchers on the section are rows of headers through length of wall, and those showing headers in section show stretchers along the length of the wall. The fourth course contains four rows of headers; the fifth, three rows of headers and one row of stretchers; and the sixth, three rows of headers along length of wall. From No. 2 course to the two and a half brick wall each course of footings decreases 2¼ inches on either side, that is to say they decrease 4½ inches each time in the width of the course until they reach the last footing course, which in this case is marked 6. This course should always be 4½ inches wider than the width of the wall. The first course in the two and a half brick wall shows two rows of headers and one row of stretchers in the length of the wall, or one row of headers on one side of the wall, one row of stretchers on the other side of the wall, and the internal space, which is then 9 inches, is filled in with another row of headers through the length of the wall. The second course of the two and a half brick wall is the reverse to the first course. The width of the concrete for this wall is 6 inches wider on the side of the first course of double footings. The depth is 2 feet 3 inches.

The plan shows the number of courses of the footings. The double course of footings, as marked in section as Nos. 1 and 2, is shown on plan as No. 1, as only the top course of this double footing can be seen. The other courses are marked on plan as 2, 3, 4, and 5. The width of concrete is 6 inches wider each side of the double course of footings, or 12 inches wider than the double footing course. The first course of the wall is shown; it consists of two rows of headers and one row of stretchers; the second course is the reverse to this.

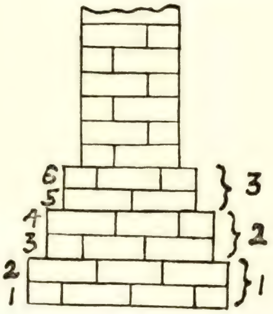


FIG. 121.

Fig. 121 gives a view of a 14-inch or one and a half brick wall, with three double course footings in this case with no concrete under the first double course of footings. Walls are sometimes built in this way when there is a very good hard natural bed to build upon. The three double courses of footings when properly bonded together form a very good foundation for the wall. The first double course of footings, as will be noticed, is three bricks in width, or twice the thickness of the one and a half brick wall. The first course of the double course contains two rows of stretchers on the outside of the footings which is filled in by two rows of headers for the length of the courses. The next course is the second course of the first double course and consists of three rows of headers. On the left hand side each course is marked thus: 1, 2, 3, 4, 5, and 6; on the right hand side the first double course is marked 1, the second double course 2, and the third double course 3. The second double course consists of two rows of headers and one row of stretchers in the first course and the reverse in the second course. The third double course is 4½ inches less than the second double course. The first course consists of two rows of headers and the second two rows of stretchers on the outside filled in with a row of headers internally. The wall itself, which is one and a half bricks in thickness, is 4½ inches less than the top double course of footings.

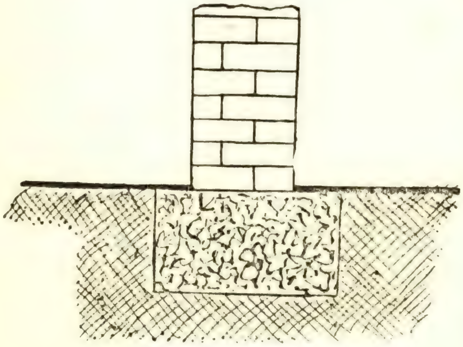
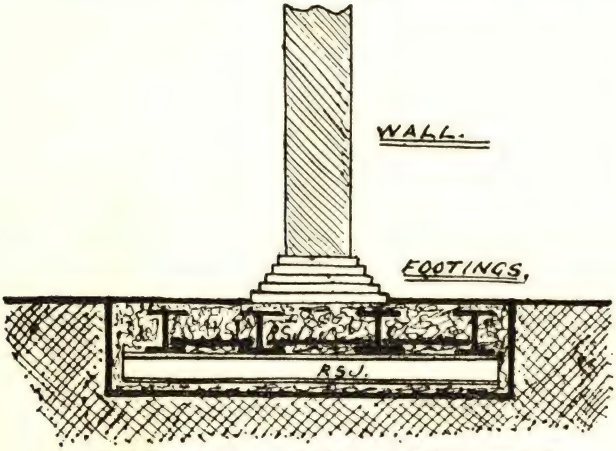


FIG. 122.

Fig. 122 is the section of a one and a half brick wall, showing the concrete, which is of a greater depth in this case. Owing to the absence of the courses of footings, walls are sometimes built in this method by starting direct off the concrete base. When this method is adopted the concrete is usually of a greater depth to replace the extra strength required by the absence of the usual courses of footings.

Grillage Foundations.—Having dealt with the various thicknesses of walls, their plans and sections of the different footings and concrete required for them, we will now pass to another kind of foundation which is required where heavy buildings are to be constructed and the ground is of a soft nature. This form of foundations are called grillage foundations. These foundations are also used to support heavy walls, piers, and also steel stanchions. They are a combination of steel and concrete, the steel being laid and interlaced in such a manner with each other as to form a kind of grill.



SECTION OF GRILLAGE FOUNDATION.

Fig. 123.

Fig. 123 illustrates the section of a heavy wall built upon one of these foundations. The trench is usually dug for the required depth of the wall or pier. A layer of concrete is then placed in the trench to a depth of several inches. Rolled steel joists are next placed in position upon this bed of concrete. This is shown and marked RSJ in the illustration. This joist is shown lying crosswise in the trench. Upon this RSJ are placed several other RSJ's in the reverse position at various intervals apart. These joists rest directly upon the upper flange of the bottom joist, practically producing a latticework of steelwork. These steel joists are sometimes bolted together to keep them in their correct positions on the bottom joists as they are liable to be pushed out of the original position when the concrete is placed between them. Another way of holding them in the correct position is to place a number of steel bars on top of the bottom flange of the second layer of joists as shown in the illustration, in a horizontal position between each two joists after all the steelwork has been placed in position. The whole is filled in with concrete to a point several inches above the top flange of the second layer of joists. This interlacing of steelwork combined with the concrete forms a very good foundation for bad ground, and spreads the weight laterally over a large surface. This foundation should stand for a time to enable the concrete to set well before being built upon. The section Fig. 123 also shows the five courses of footings for the wall, and the wall itself.

Fig. 124 gives an illustration of the plan of a grillage foundation upon which is placed a steel stanchion. In this plan three RSJ's are placed horizontally on the concrete in the excavation. The second layer of RSJ's are placed in position on the flanges of the first layer of RSJ's. These are bolted together to hold them in their correct positions. The base of the stanchion is then bolted to the three centre RSJ's, top flanges. The whole is then concreted in and the bolts at the base of the stanchion are carefully grouted in. The plan of the stanchion is shown on diagram; the base of it also shows the four bolt holes.

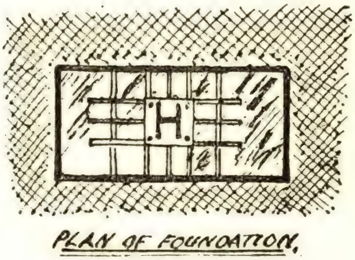


FIG. 124.

Pile Foundations.—Another form of foundation which is used in bad ground is called the pile foundation.

Fig. 125 is a system of pile foundation which is used when there is bad or loose soil, or very treacherous ground for a distance of 25 to 30 inches in depth and a solid stratum of clay or ballast beneath this. Piles are then driven through the bad ground into the solid stratum below. These piles are placed at intervals of about 3 feet apart all over the site if it is very bad ground. Sometimes, where the ground is of moderate character, a series of piles are driven under all the walls, both the main walls and cross walls. Where a site is very bad and liable to contain much water, sheet piling is used all round the outer part or boundary of the site. This is to contain one solid mass of concrete to a certain depth all over the site. In this illustration a series of piles are driven in at regular intervals apart and the heads of all the piles are then connected lengthwise and crosswise with other large timbers, usually about 12 inches by 12 inches. These are all bolted together and form a latticework. On this is nailed sheeting or rough boards; the concrete is placed on these boards to whatever depth is required to carry the walls of the building. On this concrete the various footings of the walls to be built are set out.

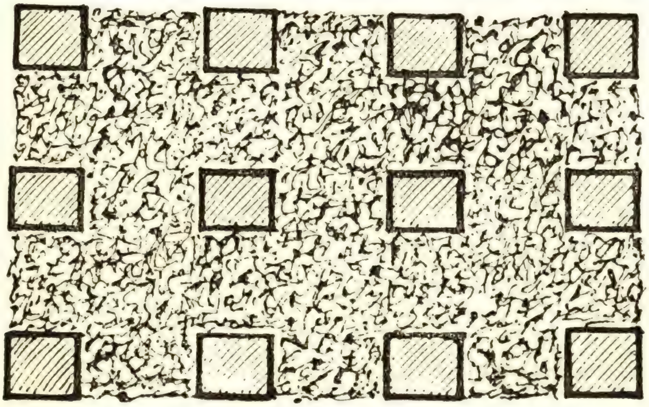


FIG. 125.

Fig. 126 is another system of piling. Piles are driven through the bad ground into the solid stratum, and placed at various regular distances apart. A certain distance below the tops of the piles the ground is excavated, and concrete is then placed in all the spaces between the piles, and is carried to a certain distance above them. So in this case the tops of all the piles are held securely in position when the concrete sets. When this layer of concrete is sufficiently hard, footings are set out and the walls constructed.

Raft Foundations.—Fig. 127 is a plan of the piles showing their positions and their correct placing in other foundations which are very bad. A bed of concrete is placed all over the complete site, sometimes to a depth of 5 to 10 feet. This is also at times reinforced with steel, etc., so as to form a complete raft of reinforced concrete over the entire site. This concrete being of a great weight much pressure is directed on to the ground beneath it, therefore having the tendency to solidify it to a great extent, thus making a firmer foundation to build upon. Large and deep beds of concrete under the main walls of buildings are placed with the same object of compressing and solidifying the ground beneath them.

Tunnelling.—Fig. 128. This is another form of timbering for a foundation which is excavated for the laying of a drain under a house, or where the surface of the ground is not required to be disturbed; this is called tunnelling. In starting these tunnels, a large hole is dug at one end of the excavation of the tunnel. When the required depth of the proposed tunnel is reached, it is excavated horizontally from the hole, say for a distance of 6 feet. A frame of timber as shown in the illustration is then placed in position in the tunnel hole. This consists usually about 5 to 6 feet in height and the average width, about 3 to 4 feet according to the size of the pipes, etc., which are to be placed in the hole, allowing for space for the men to make joints, etc., round these pipes. This timber framing is usually heavy material, sometimes 6 inches by 6 inches, or heavier according to the weight it is required to carry above it and also the weight against its sides. The framing is generally fixed in position. The bottom horizontal width between frame is wider than the horizontal width between the top of the frame; this gives greater strength. The frame is then securely fixed at each angle with spikes or dogs. The top horizontal piece is usually housed into the sides of the vertical pieces. When this is in position the back portion of the frame is sheeted or closely boarded by boards 9 inches by 1 inch by 6 feet. This stops any surplus material from falling from the sides of the excavation and also holds the sides in position. After the first portion of the tunnelling is complete and secure, a further portion is proceeded with and treated in the same way as the first. This system is carried out until the whole length is complete.

Such is a general view of the different types of foundations with which a bricklayer is likely to come into contact in ordinary practice, or a know-

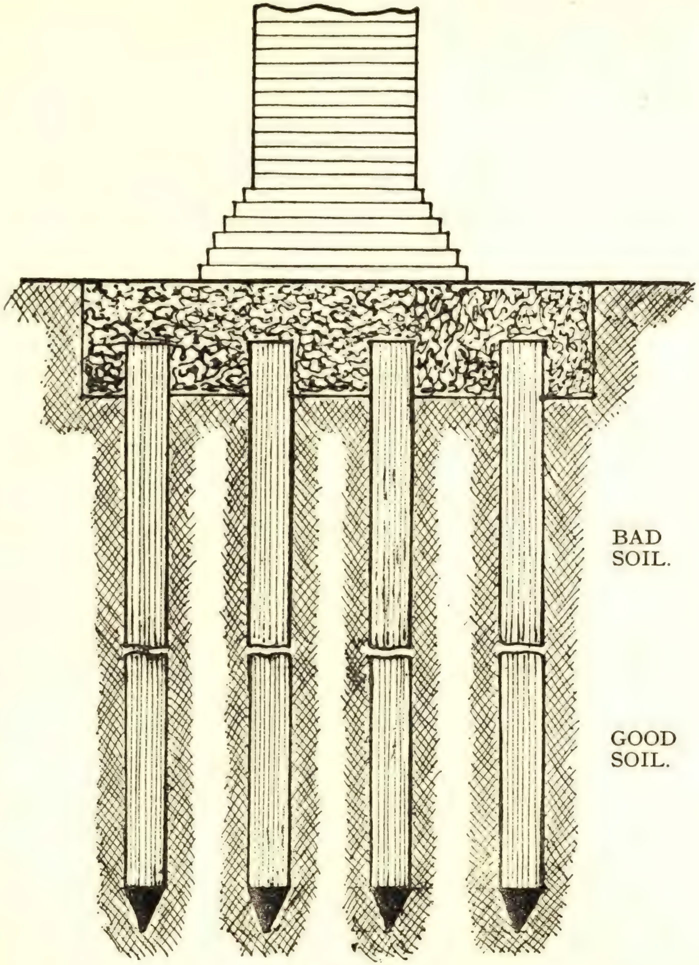


FIG. 126.

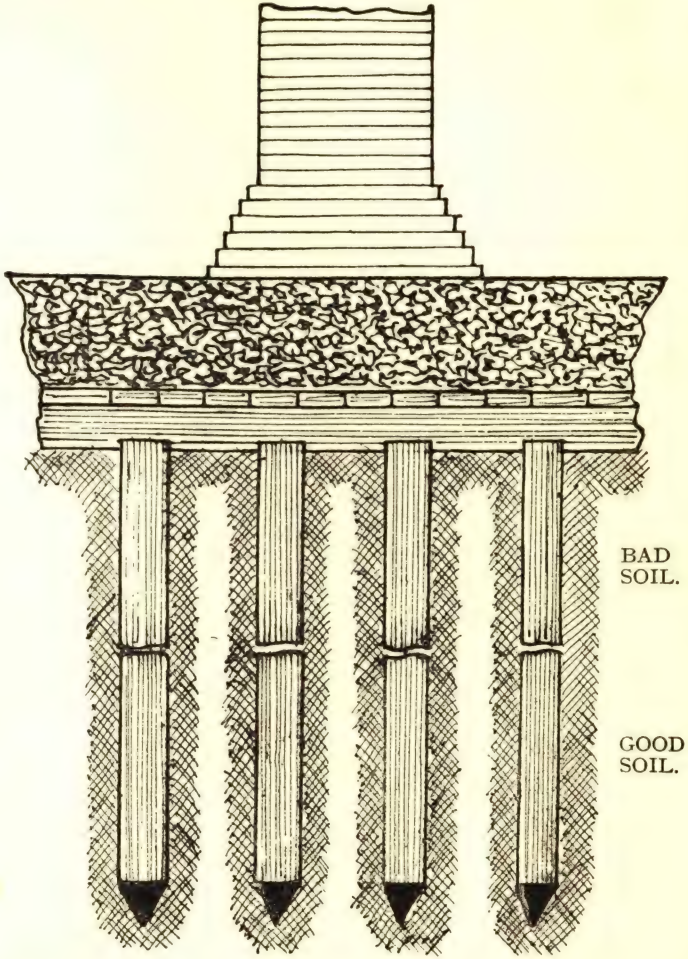


FIG. 127.

ledge of which he should possess, in case at any time he is called upon to do work of this nature, or to superintend this class of work in his capacity as foreman or superior.

It will, of course, be understood that in all important building schemes the type of foundations and their dimensions will be determined by the architect or engineer, who will supply detailed drawings. This is, in fact, always done where an architect or engineer plans and supervises work. While the plans and specifications generally lay down fairly hard and fast lines, which have to be strictly adhered to, details are largely left with the builder and his staff. On small jobs the whole responsibility of planning and erecting foundations may rest on the builder, and in any case the all-round bricklayer must possess a competent understanding of the subject.

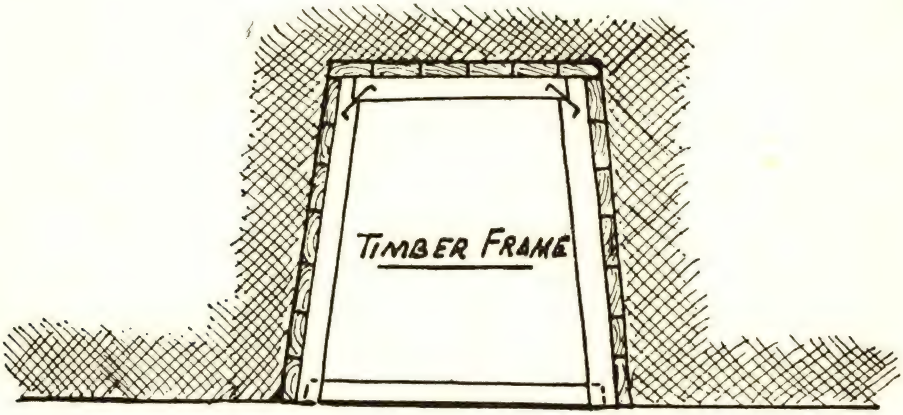


FIG. 128.

A matter closely connected with foundations is that of waterproofing, which is fully discussed in a separate chapter.

Bricks and Mortars for Foundations.—The laying of bricks in foundation work is a matter of great importance, as it must be carefully done. Usually hard bricks, of the Staffordshire blue type, are selected. In any case, they must not be absorbent and should be sound and well burnt. It is a mistake to use inferior bricks for the purpose on the plea that they are to be buried out of sight. All bricks must be thoroughly wetted before use.

Mortars require equal care. In all important foundation work—invariably in the case of heavy buildings, or where poor, permeable soils are in question—they are mixtures of hydraulic lime or of Portland cement and clean sand. Such mortars set rapidly and hard, and gain in strength when in presence of moisture. They are, therefore, specially indicated for every kind of buried brickwork. Only small batches of mortar should be gauged, just sufficient for immediate use. If it begins to harden it should be discarded. Such mortars must not be overworked.

The laying should be carried out quickly and only enough mortar used to secure good bedding, the jointing being adequate but rather thin. The joints should be full out and should not be struck or cut back; a rugged surface is no disadvantage if kept perfectly perpendicular.

Where Portland cement is used a waterproofing compound may be introduced, especially in permeable soils, or where there is fear of water rising to the foundation level.

CHAPTER VIII

JUNCTION WALLS

Right Angle Junction in English Bond—Acute and Obtuse Angle Junction Walls—Flemish Bond Junctions.

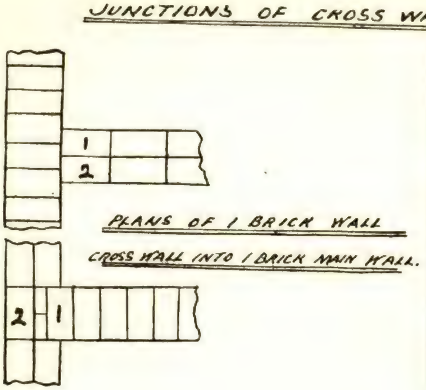
A JUNCTION wall is one which is joined on to, or abuts on, another wall, which is not continuous, in a straight line or curve. The junction is usually at an angle, though exceptionally it may be in a straight line, as in the case when an extension is carried out by toothing or otherwise. The point where the two walls meet is known as the junction.

For the purpose of explaining the following junction walls we call the front face of the main wall the external face main wall; the inside face of the main wall we will call the internal face main wall; the junction wall which joins the main wall, one side we will call the external face junction wall, and the other side we will call the internal face junction wall. All these parts in the main wall and junction wall have been named so that when describing the various bonds it will be easier to follow the instructions. The internal angles must also be described because of the importance of the ties which connect the junction wall to the main wall. This point is indeed most important and should always be bonded correctly in order to obtain the greatest strength at the junction of the walls.

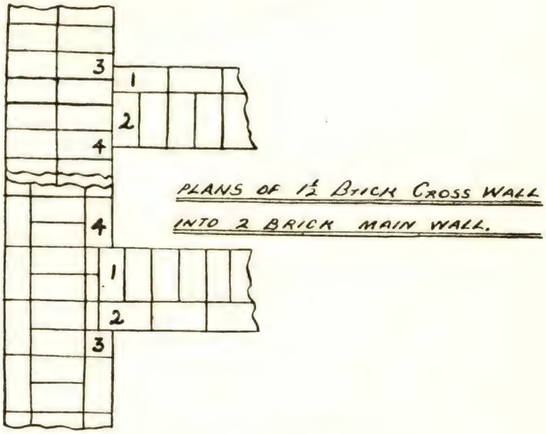
Right Angle Junction in English Bond.—Fig. 129 shows the plan of the first course of a main 9-inch wall, and a junction wall connected to it at right angles, both in English bond. The external face of the main wall consists of headers, as does the internal face, the back header facing the front external face headers form this course. The 9-inch junction wall is composed of two stretcher courses, one on the external and one on the internal face of the wall. The two internal angle stretchers marked 1 and 2 on the junction wall are placed against, and jointed to, the headers in the main wall. This forms the first vertical internal angle joint in the junction wall, showing internally and externally on the faces of the junction wall.

Fig. 130 shows the plan of the second course of a main 9-inch wall, with a 9-inch junction wall connected to it at right angles, both in English bond. The external face of the main wall is composed of a course of stretchers and the internal face of the main wall is also a stretcher course. The junction wall consists of a course of headers, and is 9 inches in thickness. This shows a heading course on the external and internal face of the junction wall. This junction wall ties into the main wall with the header marked 1, which forms the internal angles. It ties into the main wall 2¼ inches. There is a 2¼-inch space between this header and the external face header in the main wall marked 2. This is filled in with two closers. The vertical internal angle cross joints are formed by placing the internal face stretchers in main wall at either side of the junction wall header marked 1.

Fig. 131 shows the plan of the first course of a main wall, two bricks or 18 inches in thickness with a one and a half brick junction wall connected to it at right angles, both in English bond. The external face of the main wall consists of a course of headers, and the internal face course also consists of headers. The external face of the junction wall consists of a course of headers, the internal angle header marked 2 being placed against the faces of four headers in the internal face course of the main wall. The two headers marked 3 and 4 show two and a quarter of the width of their faces in the two internal corners, the stretcher marked 1 and the header marked 2 being placed against the four headers in the main wall and being jointed to them forms the internal angle vertical cross joints, which start the junction wall.


JUNCTIONS OF CROSS WALLS ENGLISH BOND.
1
2
PLANS OF 1 BRICK WALL
CROSS WALL INTO 1 BRICK MAIN WALL.
2
1

FIGS. 129 and 130.



FIGS. 131 and 132.

Fig. 132 shows the plan of the second course of an 18-inch, or two-brick, main wall with a 14-inch, or one and a half brick, junction wall, connected to it at right angles, both walls being in English bond. The external face of the main wall consists of a course of stretchers, as does the internal face. There now remains the 9-inch interior portion of the wall to be filled in. This consists of a row of headers all along the interior course. The external face of the junction wall is formed with a course of stretchers, No. 2 forming the internal angle stretcher in the junction wall. This ties into the main wall, a quarter of the length of the stretcher or 2¼ inches. The internal face course of the junction wall is formed with a course of headers. The internal angle header marked 1 in the internal face course of the junction wall ties into the wall 2¼ inches. Behind Nos. 1 and 2 in the interior portion of the wall the space is filled in with three closers. The internal angle stretcher marked 4, which is placed against the internal angle header marked 1, forms the internal angle vertical cross joint in the internal face course of the main wall. The other internal vertical angle cross joint in the internal face course of the main wall is formed by placing the bat, or half brick, which is numbered 3, against the internal angle stretcher marked 2. The bat is placed in this position so as to enable the bond in the main wall to be worked sectionally. The junction wall being of an odd bat in size in the width of the wall, necessitates the bat being placed in position to work the even number of bricks in sectional bond from the external face course. In the walls which contain a number of whole bricks, the bat is not required to form the sectional bond in the internal angle.

Fig. 133 shows the plan of the first course of a three-brick main wall with a two-brick junction wall connected to it at right angles, both in English bond. The external face course of the main wall consists of a course of headers. The internal face course of the main wall also consists of a course of headers, and these two courses, the internal and external face courses, form 18 inches or two bricks of the width of the three-brick wall. The interior part, which is another 9 inches in width, is filled in with a course of headers. This completes the whole width of the main wall. The junction wall external face course consists of a course of stretchers, starting from the internal angle stretcher No. 2. The internal face course of the junction wall also consists of a course of stretchers starting from No. 1, which is the internal angle stretcher. There is 9 inches internal work to be filled in between the two courses of stretchers, which is done with a course of headers laid sectionally to the stretchers on the internal and external faces of the junction wall. The internal angle vertical cross joint is formed by the bricks marked 1, 2, and 3, being placed against the five headers on the internal course of the main wall. This joint shows in the internal and external angle of the junction wall, and runs throughout the width of the wall.

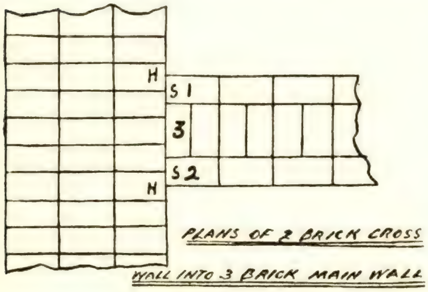


FIG. 133.

Fig. 134 shows the plan of the second course of a three-brick main wall with a two-brick junction wall connected to it at right angles, both in English bond. The external face course of the main wall consists of a course of stretchers. The internal face course of the main wall also consists of a course of stretchers, and these two four and a half courses form 9 inches of the three-brick main wall. The internal 18 inches is filled in with two courses of headers laid sectionally with the stretchers on the internal and external faces of the main wall. The external face of the junction wall consists of a course of headers, and the internal face of the junction wall also consists of a course of headers, these two courses forming the width of the junction wall, which is 18 inches. The internal angle header marked 1 ties into the main wall 2¼ inches. The internal angle vertical cross joint in the internal face course of the main wall is formed by placing the internal angle stretcher against the internal angle header marked 1. The other internal angle cross joint is formed by placing the internal angle stretcher against the internal angle header marked 2.

In these two illustrations of the three-brick main walls, with the two-brick junction walls connected to them, internal angle headers have been marked with an H, and the internal angle stretchers with an S, so that these points can be clearly understood at a glance.

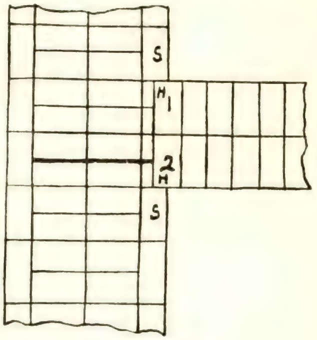


FIG. 134.

Acute and Obtuse Angle Junction Walls.—We will now proceed to consider another form of junction wall, those which connect to the main wall in a different angle, that is, an acute or obtuse angle.

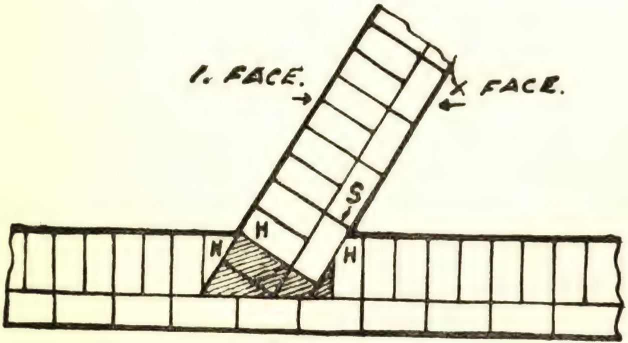


FIG. 135.

Fig. 135 is an illustration of one of these walls, showing the plan of the first course of a main wall 14 inches, or one and a half brick, in width, with the junction wall connected to it at an angle, both the walls being in English bond, one side of the junction wall forming an acute angle with the internal face of the main wall, while the other side of the junction wall forms an obtuse angle with the internal face of the main wall. The external face course of the main wall in Fig. 7 is formed with a course of stretchers, while the internal face course of the main wall is formed with a course of headers. The external face course of the junction wall, which is marked by an X, consists of a course of stretchers, and the internal face course of the junction wall, which is marked with 1, is composed of a course of headers. The internal angle header, and the internal angle stretcher, which are marked S and H at the acute angle of the wall, form the internal angle vertical cross joint on the internal face course of main wall. This internal angle header marked H has a portion taken from it on the left hand top corner. This cut-away piece is 2¼ inches in width. This leaves 2¼ inches to form the internal angle closer. The internal angle vertical cross joint on the obtuse angle side of the junction wall, which is the joint at the right hand side of the wedge-shaped brick in the internal angle, is formed by placing this wedge-shaped brick against the two internal pieces as shaded; the other filling-in pieces are also shaded, so it will be seen that the junction wall in this case is tied into the main wall to within 4½ inches of the external face of the wall.

Fig. 136 shows the plan of the second course of a one and a half brick main wall, and a one and a half brick junction wall, connected to it at an angle, both in English bond. The external face course of the main wall consists of a course of headers, and the internal face course of the main wall consists of a course of stretchers. The external face course of the junction wall consists of headers, whilst the internal face course of the junction wall are stretchers. The internal angle vertical cross joint is formed by the placing of the internal angle header, which is marked H, and is on the acute angle side of the junction wall, against the shaded portion, which is a stretcher in the interior of the wall. This internal angle header has 2¼ inches removed from its face, and shows 2¼ inches on its face from the internal vertical angle cross joint. This header in the internal angle is really a king closer. The shaded portions are a stretcher and a small wedge-shaped piece of brick which are required to form the internal bond. The internal vertical angle cross joint on the obtuse angle side of the junction wall, which is the first joint in the internal angle on the internal face course of the junction wall, is formed by placing the bat B in the internal angle against the stretcher in the internal angle marked S. This vertical angle cross joint extends from the internal face of the junction wall to the external face of the junction wall. We will now proceed with the junction walls in Flemish bond.

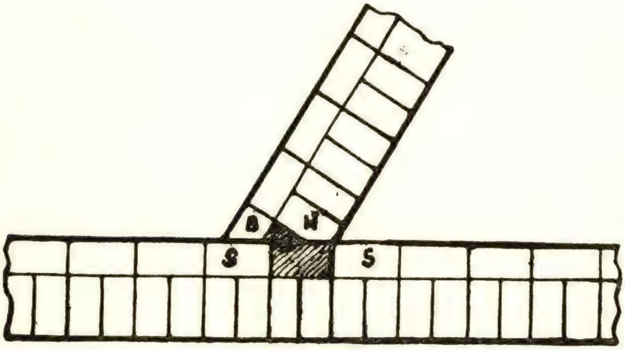
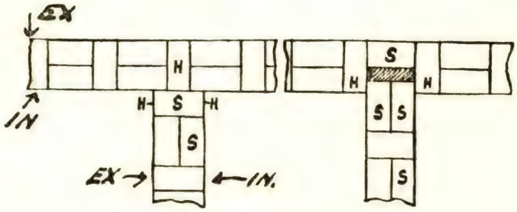


FIG. 136.

Flemish Bond Junctions.—Fig. 137 shows the plan of the first course of a 9-inch main wall, with a 9-inch junction wall connected to it at right angles, both in Flemish bond. In these diagrams EX refers to the external face of a wall and IN to the internal face, arrows being introduced to assist in following the directions. The external face course of the main wall in Fig. 9 consists of headers and stretchers alternately along the course. The internal face course of the main wall shows the same bond. The actual bricks laid in this course are the stretchers, which are filled in between the headers already laid to the external face course of the main wall. The external face course of the junction wall starts with the internal angle header, marked each side of the junction wall externally and internally with an H, it is also marked S as a stretcher when laid against the back of the external face header in main wall. This internal angle header in the external face junction wall should be laid centrally to the header marked H in the main wall. This header, when fixed against the main wall header marked H, forms the vertical internal angle cross joint and shows in the internal angle on the external and the internal faces of the junction wall. From this internal angle header the bond continues stretcher and header alternately along the course of the external face of the junction wall, and the stretchers marked S are the stretchers which are filled in between the headers, which form the internal face course of the junction wall.

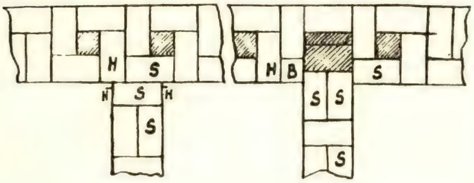


PLANS OF 1 BRICK WALL

FIGS. 137 and 138.

Fig. 138 shows the plan of the second course of a 9-inch main wall, and a 9-inch junction wall connected to it at right angles in Flemish bond. The external face course of the main wall consists of headers and stretchers alternately long the whole course. The stretcher marked S on the external face course of the main wall forms the internal and external face lines of the junction wall. The internal face course of the main wall consists of filling in the stretchers between the headers which are laid on the external face course of the wall. The back faces of these form the internal face course of the main wall. The junction wall external face course starts with the internal angle stretcher marked with an S, and then follows headers and stretchers alternately along the course. The internal face course of the junction wall consists of the Flemish bond. The headers already being in their position, stretchers are filled in between them as marked SS to complete the course. The external face course of the junction wall, of which the internal stretcher starts the course, is marked S, and ties into the main wall 2¼ inches. The internal angle stretcher, which is placed at the back of this on the internal face course of the junction wall, and marked S also, ties into the main wall. Two and a quarter inches beyond these two face stretchers is placed a queen closer, which fills the 2¼ inches by 9 inches of space. The internal angle vertical cross joints are formed by the two internal angle headers marked HH, these being placed against the internal angle stretchers in the junction wall.

Fig. 139 shows the plan of the first course of a one and a half brick main wall with a 9-inch junction wall connected to it at right angles, both in Flemish bond. The external face course of the main wall consists of headers and stretchers alternately all through the course. The internal face course of the main wall also consists of headers and stretchers alternately all through the course. The shaded portions as shown are the bats which are required to be filled in in the internal $4\frac{1}{2}$-inch centre portion of the wall. The 9-inch junction wall is placed against the header and stretcher on the internal face course of the main wall, which are marked with an H and a C. The first brick in the junction wall, laid as a stretcher against the internal face of the main wall and marked S, forms the two starting faces, and marked H- -H as shown, of the internal and external angles of the junction wall. It also forms the internal angle vertical cross joints on both of the faces of the junction wall. The junction wall is then continued in Flemish bond along the whole course as in the case of Fig. 9 junction wall.

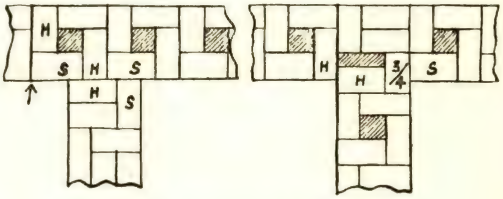


PLANS OF 9" WALL INTO $1\frac{1}{2}$ BRICK WALL.

FIGS. 139 and 140.

Fig. 140 shows the plan of the second course of a one and a half brick main wall, with a 9-inch junction wall connected to it at right angles, both in Flemish bond. The external face course of the main wall consists of headers and stretchers alternately all through the course. The internal face course of the main wall, which starts with a bat or half brick and marked B, follows on with another header next to it marked H. This bat is placed in this internal angle so that the Flemish bond may work sectionally from the external face of the main wall. The internal angle stretcher, marked S on the internal face of the main wall, starts the Flemish bond, having next to it headers and stretchers alternately all through the course. The two internal angle stretchers on either side of the face of the junction wall start the Flemish bond along the wall. They also tie into the main wall $2\frac{1}{4}$ inches, showing three of the length of a brick on the face from the internal angle. These two stretchers, placed against the internal angle bat and the internal angle stretcher on the internal face course of the main wall, form the internal angle vertical cross joints at either side of the junction wall. The shaded portions are the half bricks, required to be filled in to form the proper internal bond. One whole brick and one queen closer are also shaded, these forming the continuation of the tie of the junction wall into the main wall.

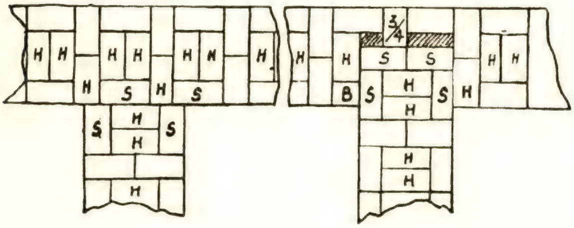
Fig. 141 shows the plan of the first course of a one and a half brick main wall, with a one and a half brick junction wall connected to it at right angles, both walls in Flemish bond. The external face course of the main wall consists of headers and stretchers alternately all through the course. The internal face course of the main wall consists of the same bond throughout the course, the position being shown on the internal face where the internal angle stretcher, marked S on the internal face course of the main wall, is on the left hand side of the junction wall. The left back half of this stretcher is placed against the back of the header marked H in the external face course. These bricks being placed in this position, the left end of stretcher marked with an arrow, and the left side of the header in the external face course of main wall, work sectionally with each other, and as will be seen this transverse vertical cross joint is obtained every brick and a half or every 14 inches throughout the length of the wall when this bond is worked. The bats which are placed in position in the central 4½-inch portion of the interior of the main wall are shaded. The external face course of the junction wall starts with internal angle headers marked H which are placed against the headers centrally, which are in the main wall and also marked H. That is to say, the centre of the header which starts the junction wall would be a point 4½ inches along its stretcher face, when placed against the centre point of the header in the main wall, and the centre of the main wall header would be the centre of the width of its face, which will be 2¼ inches. These two points should come exactly opposite each other in the placing of the first header which forms the first brick in the junction wall from the internal angle. Next to this is placed another header also marked H. Next to it stretchers and headers follow alternately along the whole course. The internal face course of the junction wall starts with the internal angle stretcher, and then follow headers and stretchers alternately along the whole course. This internal angle stretcher on the internal face course of the junction wall works sectionally with the two headers on the external face of the junction wall. The internal angle vertical cross joint, which runs from the external to the internal face of the junction wall, is formed by placing the internal angle bricks of the junction wall, marked H and S, against the bricks in the internal main wall course marked SHS. The bats in the internal centre 4½-inch portion of the wall are shaded.



PLANS OF 1½ BRICK WALL.

FIGS. 141 and 142.

Fig. 142 shows the plan of the second course of a one and a half brick main wall with a one and a half brick junction wall, connected to it at right angles, both in Flemish bond. The external face course of the main wall is formed of headers and stretchers alternately all along the whole course. The internal face course of the main wall at the left hand side of junction wall starts with an internal angle header marked H, and then follow stretchers and headers alternately all through the course, worked sectionally with the external face course of the main wall. The right hand side of the junction wall starts with the internal stretcher in the internal angle of the internal face course of the main wall and then follow headers and stretchers alternately all through the whole course. The junction wall starts with the internal angle header on the external face course of the wall, and then follow stretchers and headers alternately all along the whole course. The internal face of the junction wall starts with an internal angle three-quarter brick, and then follow headers and stretchers alternately all along the whole course. This three-quarter brick ties into the main wall half of the length of a stretcher or 4½ inches, the remaining 2¼ inches showing on the face in the internal angle of the junction wall. The internal angle header which backs this three-quarter in the junction wall also ties into the wall 2¼ inches. Beyond this internal angle header is placed a queen closer, which is shaded. This again forms the correct internal bond in the wall. The bats are also shaded, which are in the centre 4½-inch portion of the internal part of the wall. The vertical internal angle cross joint is formed by placing the stretcher, which is at right hand side of junction wall, against the three-quarter brick in the internal angle of the junction wall; the one at the left hand side of the junction wall in the internal angle is formed by placing the internal angle header in the internal face course of main wall, against the internal angle header in the junction wall.



Figs. 143 and 144.

Fig. 143 shows the plan of the first course of an 18-inch main wall, with an 18-inch junction wall connected to it at right angles, both in Flemish bond. The external face course of the main wall consists of stretcher and header laid alternately along the whole course. The internal face of the main wall also consists of headers and stretchers laid alternately along the whole course. The headers, which show on the internal face of the main wall, are in a direct horizontal line, and are laid at the back of the headers which are in the external face course. This occurs with all the headers along the course, and forms the correct sectional bond in the internal part of the wall. Between the headers two stretchers are laid, one on the external and one on the internal face of the main wall. The internal portion between these two face stretchers is 9 inches by 9 inches. This is filled in with two headers, which are marked HH all along the wall between the two headers which show internally and externally on the face of the main wall.

The junction wall starts in the internal angles with a stretcher on the external face and also a stretcher on the internal face. In between these two external and internal face stretchers are placed two headers marked HH. Next to these are two headers, one showing on the internal and the other showing on the external face of the junction wall. This system is repeated from the internal angles throughout the length of the junction wall. The internal vertical angle cross joint is the first angle cross joint in the junction wall. This is formed by placing the external and internal angle stretchers of the junction wall against the bricks in the internal face of the main wall, which are marked, starting from left to right, HS HS.

Fig. 144 shows the plan of the second course of an 18-inch main wall, with an 18-inch junction wall connected to it at right angles, both in Flemish bond. The external face course of the main wall consists of headers and stretchers laid alternately along the whole course. The internal face of the main wall, starting from the left hand side of the junction wall in the angle, consists of a bat, or half brick, marked B. This is backed internally by a header marked H. Next to the bat on the internal face is placed the header which works sectionally with the header at the back of it, and shows on the external face of the main wall. Next is placed the stretcher, which is backed internally by two headers. This continues along the whole course. The internal angle header marked H, showing on the right hand side of the junction wall, starts the Flemish bond along this internal face of the main wall. Next to it are placed stretchers and headers alternately along the whole course. The junction wall starts with the two internal angle stretchers, one on the external and the other on the internal face, marked SS. The two stretchers tie into the main wall, three-quarters of the length of a brick, and show the other quarter or 2¼ inches on the internal angle. The 9-inch internal space between these two stretchers is filled in with two headers, which are marked HH. Next to these two internal angle stretchers in the junction wall are placed two headers, one showing on the external and the other on the internal face of the junction wall. Next to these are two stretchers on either face. This bond continues throughout the whole course. Beyond the two internal angle stretchers of the junction wall are shown two stretchers marked SS, also one ordinary closer in shaded lines, and one queen closer also in shaded lines. There is a three-quarter brick placed between them, which shows as a header on the external face course of the main wall. The internal angle vertical cross joint, left hand side of the junction wall, is formed by the placing of the bat marked B against the internal angle stretcher in the junction wall. The internal angle vertical cross joint at the left hand side of the junction wall is formed by placing the internal angle header in the internal face course of main wall, marked H, against the internal angle stretcher marked S, in the internal angle of the junction wall. Both these internal angle vertical cross joints show in the internal angle in the internal face course of the main wall.

CHAPTER IX

ANGLES

Angles as Points of Control—Gauging the Courses—Angles in English Bond—In Flemish Bond—In Double Flemish Bond—English Bond Details—Acute and Obtuse Angles—In English Bond—In Flemish Bonds.

SQUARE angles form a very important factor of construction in all brickwork, and they require the greatest care in being carried out from top to bottom. While these square angles are the most commonly met with in everyday practice, others are often used, and the need for accuracy and neatness applies equally whatever their shape or size. This will be easily understood when it is realised that all intermediate brickwork between any two angles is guided by them, both as regards the perpendicular, and in relation to the exact width of the wall.

ANGLES AS POINTS OF CONTROL

If, for instance, the square angle, or any other being built, is ever so slightly out of the perpendicular, the irregularity will be repeated in all the wall between, because that angle is the beginning or the end of that wall. Obviously there must always be two angles, though not necessarily both alike. Now, if one angle is built in a perfectly perpendicular position, and the other, through faulty construction, is found to be slightly battering or overhanging, the irregularity will start from the angle which is not built correctly, and gradually diminish as it proceeds along the intermediate brickwork towards the angle which has been built correctly.

This irregularity in relation to the battering or overhanging of the brickwork would show itself along the whole length of the intermediate brickwork if the two angles were constructed wrongly, either overhanging or battering. Therefore it must be well understood that if the two angles are built in a correct perpendicular position, the whole of the intermediate brickwork between them would also be correct. This also applies to the angles which are built smaller or larger in width ; the whole intermediate brickwork would be affected in the same way as in the former case. So it is very important that all angles in any building should be constructed in a proper manner. If this is not done, it has a serious effect on the walls of the buildings, as these are absolutely governed by these angles.

Gauging the Courses.—Another important point which we must not omit is the correct gauging of the courses at all angles. If one angle, for example, is gauged at four courses to the foot, that is, 3 inches for each course, with the brick and joint included, exactly the same dimensions must be found in the other end, otherwise there will be different heights, with the result that the intermediate brickwork will not be horizontally level.

In the construction of angles, all these important points have to be studied as the work proceeds.

Fig. 145 gives an isometric view of an angle or corner of a 9-inch wall built in Flemish bond. This is intended to show some of the important points in the construction of angles. The dotted lines as shown, AB and CD, are the two important plumbing points near the corner of the wall. These points should be plumbed at intervals as the work on the angle proceeds. It should be about 2¼ inches from the corner point, and, as shown, should be plumbed on both faces of the wall, that is, the point in the first course taking the corner stretcher 2¼ inches from extreme left end of stretcher and on the return the point should be taking the first course. At the return face of the stretcher, which is a header, the plumbing point should be in the centre of the header, or 2¼ inches from the extreme angle point. These points being in a correct perpendicular position, the short straight edge should be used from time to time in a position on the face of the wall, left and right from the angles, as shown by the dotted lines marked with a cross at the lowest ends. All the intermediate bricks between the plumbing point at angle, and the lowest point as marked with cross, should touch the straight edge and form a straight face line between these points. Before many courses are built at the angle, the exact gauge should be studied. As a rule, the experienced bricklayer can judge the first two or three courses in relation to the gauge in which the brickwork has to be built.

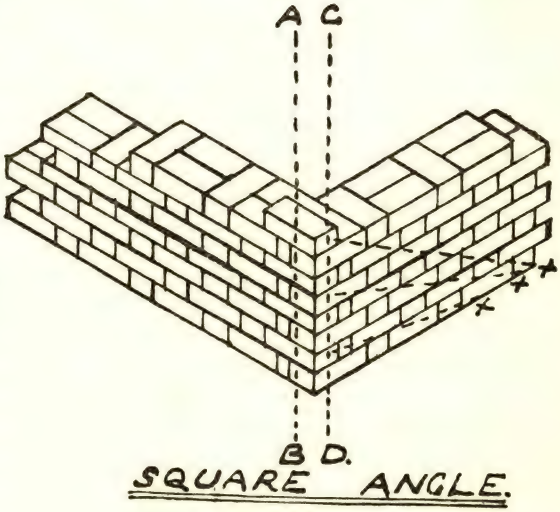


FIG. 145.

Fig. 146 is an illustration of the elevation of a piece of brickwork in English bond showing clearly the meaning of the gauge in brickwork. On the right hand side are four courses numbered 1, 2, 3, and 4, which, according to gauge, should be 12 inches to the dotted line at the top of arrow point from the floor level or bottom of arrow point. This includes four courses of bricks, and four joints: first, the joint on the floor and the first course of bricks; secondly, the joint on the first course of bricks and the second course; thirdly, the joint on the second course of bricks and the third course of bricks; fourthly, the joint on the third course of bricks, and then the fourth course of bricks. The top of the fourth course of bricks should measure 12 inches. On the left hand side will be seen the joints of brickwork marked 1, 2, 3, and 4, and also the courses 1 to 8. The dotted horizontal lines show two divisions this side of 12 inches each, thus showing that from the floor line to the top of the horizontal line the level of the eighth course of brickwork the exact measurement should be 24 inches. The depth of each course of brickwork, if, for example, they are built in stocks from the bottom to top of brick, would be about $2\frac{5}{8}$ inches to $2\frac{3}{4}$ inches, the rest being made up with the thickness of the joint to make the full gauge of 3 inches. Of course, if the bricks are " full " as termed in the trade, the joint then would be much thinner. Bricks vary a great deal in thickness, also in length and breadth. On the elevation in the centre will be seen a peg which is driven into the ground, the top of which should be exactly level to the horizontal line at the top of the fourth course. This peg is placed in position and held firmly by placing cement around it. A long rod, usually about 10 feet high and marked off by saw cuts in divisions of 3 inches, which represent courses, is placed up against the permanent peg for the purpose of gauging the brickwork up to that height. Above that height, for the purpose of continuing the gauging of the brickwork, a horizontal piece of wood, or a double course of hoop iron, is inserted into the face of the brickwork, level with the top part of the course at the top of the 10-foot gauge rod which has been placed on the bottom peg. In this way the building of the various corners, and also various points between them, can be gauged at intervals, and the whole building kept horizontally level.

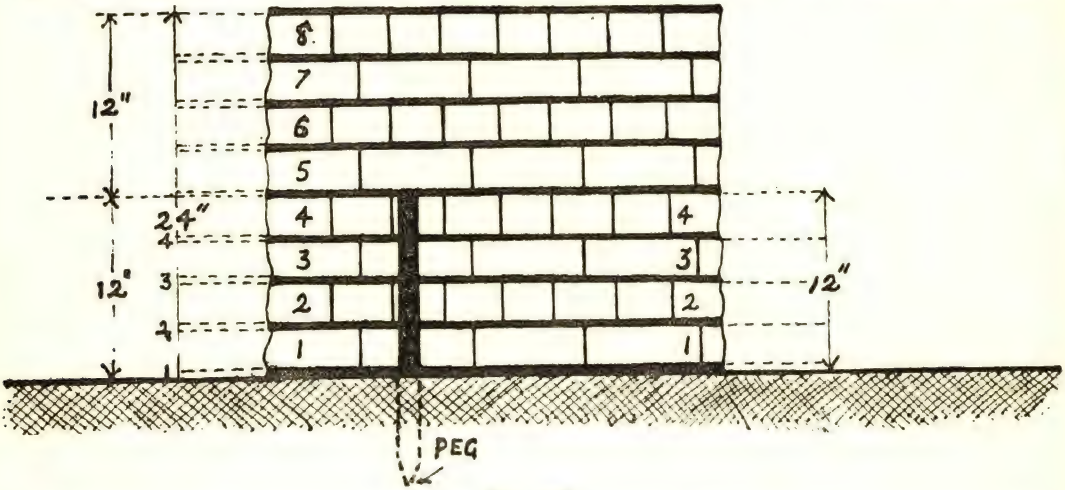
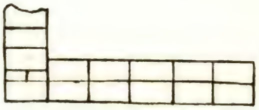


FIG. 146.

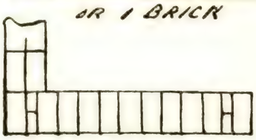
Angles in English Bond.—Fig. 147 is the plan of a 9-inch corner built in English bond. This first course contains one course of stretchers on the face, and a course of headers on the return face, starting from the header corner brick, closer next to it, and headers following along the course.

Fig. 148 is the second course of the 9-inch corner. This contains header, closer, and headers along the face, and stretchers on the return face.

Fig. 149 gives a plan of the 14-inch corner, or the standard thickness wall of one and a half bricks in width. Here we have stretchers on the face of work, and headers on the return face, with closer next to the corner header to form the correct bond. Internally, there are headers at the back of face stretchers and stretchers at the back of the face headers. The internal corner face header works sectionally, while with the second half of the face stretcher, the return internal stretcher works sectionally with the second and third header or the external return face. This internal corner stretcher ties into the wall three-quarters of its length, leaving a quarter showing on the internal corner face.



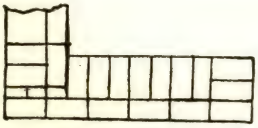
9" CORNER WITH STOP END OR 1 BRICK



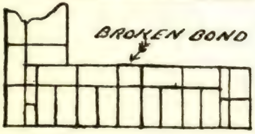
9" CORNER 2ND COURSE: OR 1 BRICK

FIGS. 147 and 148.

Fig. 150 shows the plan of the second course of the 14-inch corner. The face of the wall externally shows headers along the course with the closer next to corner header, and stretchers on the return face. Stretchers are shown at back of face headers, and headers the back of face stretchers. We have a bat introduced in the stretching course at the back of the face headers, because a broken bond is necessary, owing to the wall being an odd half brick in length to the end of the wall.



1½ BRICK 1ST COURSE

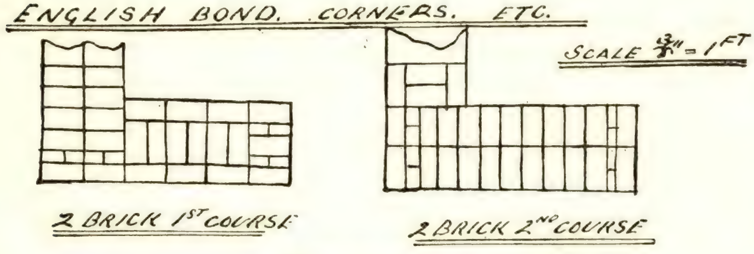


1½ BRICK 2ND COURSE

FIGS. 149 and 150.

Figs. 149 and 150 both show stop ends to the wall. In the first course three headers are placed, and their face at end of wall is shown. In the second course, two three-quarters are shown on face of wall at the end. These two three-quarter bricks in the second course are placed over the three headers in the first course, thus forming the correct bond.

Fig. 151 is an illustration of the corner of an 18-inch wall or two-brick wall in English bond. This contains stretchers on the external face and header, closer, and headers on the return external face. A course of stretchers is formed from the internal corner outwards at the back of the face stretchers, there being 9 inches between the two. This is filled in by a course of headers, two internal headers working sectionally with the two external stretchers along the length of the wall. The internal face return consists of a course of headers. These are placed at the back of the return external face headers. The internal corner header ties into the wall 2¼ inches. The internal corner stretcher is butted against it, and forms a perpendicular cross joint in the internal corner in the stretching course. This corner also shows a stop end, which consists of three headers and two closers showing on the end face of wall.

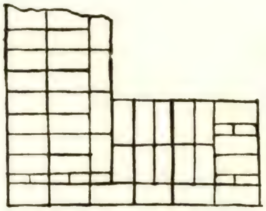


2 BRICK 1ST COURSE

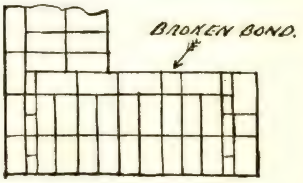
2 BRICK 2ND COURSE

FIGS. 151 and 152.

Fig. 152 is an illustration of the second course at the corner of an 18-inch or two-brick wall in English bond. The face of wall externally consists of heading course, starting at corner, with header, closer, and headers along the course. The return external face consists of a course of stretchers. The internal face consists of a course of headers which form the back 9 inches to the external face heading course. The return internal corner is formed of a course of stretchers opposite to the external return face stretchers, while the middle 9 inches is filled in with headers. The internal angle stretcher in this case also butts against the internal angle header, the stretcher in the internal angle again forming the perpendicular joint in the angle. This time it is in the internal face return course. In the course below it is in the internal face course. Again we have the stop end. This time it is formed with two stretchers showing on the end face. These two stretchers work quarter bond with the three headers and the two closers in the course below.



2½ BRICK 1ST COURSE



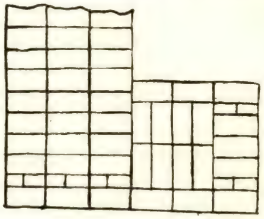
2½ BRICK 2ND COURSE

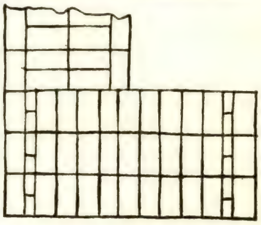
FIGS. 153 and 154.

Fig. 153 gives a view of the corner of a two and a half brick wall in English bond. The external face consists of a course of stretchers. The return external face consists of headers, viz. corner header, next to it the closer, and then a full course of headers. The internal face consists of a heading course except at the stop end of the wall, which consists of four headers and two closers. The return internal face consists of a course of stretchers. Between this course of stretchers on the internal return face and the course of headers on the external return face there is a space of 9 inches. This is filled in by a course of headers, which completes the width of the wall, viz. two and a half bricks. The same method is carried out between the external face and the internal face.

Fig. 154 is an illustration of the second course, or the course above the one just mentioned. The external face is composed of a course of headers, with a closer next to the corner header, and also a closer next to the stop end of wall. The return external face consists of stretchers. The internal face is a stretching course, but with the stop end in this position it includes a half brick in the stretcher course, thus breaking the bond. Therefore we have the bat or half brick as indicated by the arrow placed in that position to form the correct bond, from the internal corner to the stop end of the wall. The internal return face consists of a heading course, and the filling in is the same as in the first course, as already explained. The internal angles in both these courses start with the header and tie in one with the stretcher, three-quarters of the stretcher forming the internal angle tie, and one quarter of it showing on the face of the wall. This is reversed in each course.

Fig. 155 shows the angle or corner of a three-brick wall in English bond. The external face consists of a stretching course, and the return external face consists of a heading course, with a closer next to corner header to form the correct bond. The internal face consists of a row or course of stretchers, and the internal return face consists of a course of headers. The internal angle is tied in, in this case with 2¼ inches of the header, the stretcher being placed against it on the return course. In all cases where we have walls which are composed of any number of whole bricks in width, the external and internal face of the wall are the same, as in this case, where the external face and the internal face, and also the external return face and the internal return face, are the same. The external face being a stretching course, and the internal face being a stretching course also, there is a space of 18 inches to be filled in the internal part of wall, which is done with two courses of headers, making up the width of three bricks. The stop end of the wall is faced with headers, and two closers next to external headers.


3 BRICK 1ST COURSE


3 BRICK 2ND COURSE.

FIGS. 155 and 156.

Fig. 156 shows the three-brick wall in the reversed position, which in the second course consists of headers on the external face, stretchers on the return external face, headers on the internal face, and stretchers on the return internal face. In all walls in which we have an odd half brick in the thickness of the wall, such as the one and a half brick wall and the two and a half brick wall, it is necessary to reverse the course internally as compared with the exterior—that is to say, in the case of the standard or one and a half brick wall, we have a course of stretchers on the external face, and a course of headers on the internal face. Also, we have a course of headers on the return external face, and a course of stretchers on the return internal face.

These examples of English bond, which have been given from the 9-inch wall up to the 27½-inch wall or three-brick wall, will give the student a good idea of the bonds used in the various corners of these walls. We will now proceed to the next bond, describing the various angles as built in single Flemish bond.

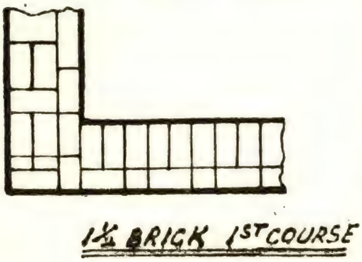


FIG. 157.

Angles in Single Flemish Bond.—Fig. 157 is an illustration of the plan of a corner of a one and a half brick wall, or the standard thickness wall. This being the minimum width of wall which is built in single Flemish bond, the 9-inch wall is either built in English bond or double Flemish bond. On the external face in Fig. 157, it starts on the corner with a stretcher, a three-quarter brick next to it showing header on face, and then stretcher, header alternately along the course. The return external face consists of the corner header, a closer next to it and then stretcher, header alternately along the course. The internal face consists of a course of headers, starting with a header in the internal angle. The return internal face consists of a course of stretchers, starting with the internal angle stretcher, which ties into the wall, three-quarters of its length, and the other quarter showing on the internal return face of wall. The vertical internal angle cross joint is thus formed by placing the internal angle header against the internal angle stretcher.

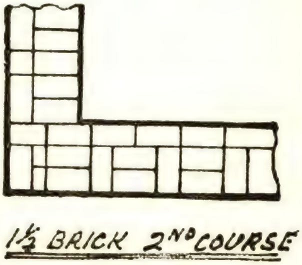


FIG. 158.

Fig. 158. This shows the second course of the corner plan of the one and a half brick wall in single Flemish bond. The external face consists of corner header, closer next to it, and then stretcher header alternately along the course; the return external face consists of corner stretcher, three-quarter next to it, showing header on face, and then stretcher, header alternately along the course. The internal face shows a course of stretchers, starting with stretcher in the internal angle, which ties into the wall three-quarters of its length, and shows 2¼ inches on the internal angle face. The return internal face consists of a course of headers, starting with a header in the internal angle, against the internal face angle stretcher. This forms the vertical angle joint in the internal angle.

Fig. 159 shows the plan of the corner of an 18-inch wall in single Flemish bond. The external face consists of the corner brick which is a stretcher, next to it a three-quarter brick showing header on the face, and next stretcher, header alternately along the course to the stop end of the wall. The return external face consists of the corner brick, which this time forms the header, next to it is the closer and then stretcher, header following alternately along the course. The internal face consists of a stretching course, which in this case, owing to the position of the stop end of the wall, necessitates a broken bond which will be seen next to the stop end corner stretcher where the bat is placed in position. The space between the external face and the internal face is 9 inches. This is filled in with a course of headers. In this case, as well as the one and a half brick wall, the external face brickwork is composed of a number of half bricks or bats; therefore the construction is not as strong as the English bond, which shows the weak points in single Flemish bond. The stop end of this wall consists of three headers and two closers. The return internal face consists of a heading course, the internal angle header which ties into the wall 2¼ inches, also the internal angle stretcher being placed against this header forms the internal angle vertical joint in the stretching course of the internal face.

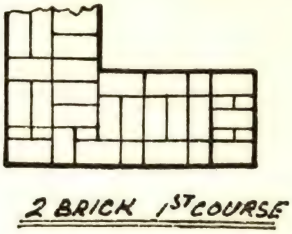


FIG. 159.

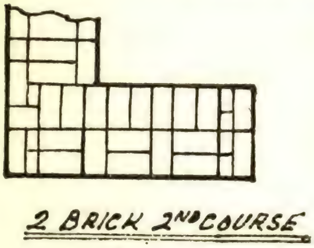


FIG. 160.

Fig. 160 shows the second course of the plan of the corner of an 18-inch wall built in single Flemish bond. The external face consists of the corner header, next to it the closer, and then the stretcher, header alternately along the course to the stop end where there is another header and closer to form the bond. The stop end in this second course consists of two stretchers, which show on the face of the stop end of the wall. The return external face consists of the corner stretcher, and next to it the three-quarter, which is the header on the face, and then stretcher, header alternately along the return external face of wall. The internal face consists of a course of headers, the internal angle header ties into the wall 2¼ inches, the return angle stretcher is placed against this, and forms the starting of the stretching course along the return internal face of wall. It also forms the internal vertical joint in the internal angle.

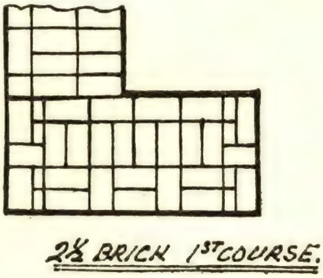
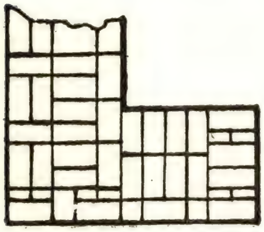


FIG. 161.

Fig. 161 shows the plan of the first course at the corner of a two and a half brick wall, in single Flemish bond. The external face consists of the corner header, with closer next to it, and stretcher, header following alternately along the course. At the back of the stretchers on the external face, another stretcher is placed, thus forming the 9-inch front portion of the wall. The return external face consists of the corner stretcher, the header next to it, which is a three-quarter from the face of the wall inwards, and then stretcher and header laid alternately along the course. This practically forms 4½ inches of the return external face of wall. The internal face of wall consists of the stretcher course. The internal angle stretcher ties into the wall three-quarters of its length, and shows 2¼ inches on the stretcher course internal face. The closer and header complete this course at the stop end of the wall, and shows two stretchers and one header on the face of the stop end of the wall. The external face, which forms 9 inches of the wall, and the internal face, which forms 4½ inches of the wall, thus leave a space of 9 inches internally between the two, which is filled in with a course of headers. The internal return face consists of a row or course of headers, thus again leaving 9 inches internally between the return internal face and the return external face. This again is filled in with a course of headers. And again in this plan, we have a series of bats or half bricks on the return external face of the wall, which forms a series of straight vertical internal joints, 4½ inches from the face of the wall. The header in the internal angle, which is placed against the internal angle stretcher, forms the angle vertical joint in the internal return face of the heading course.



2½ BRICK 2ND COURSE.

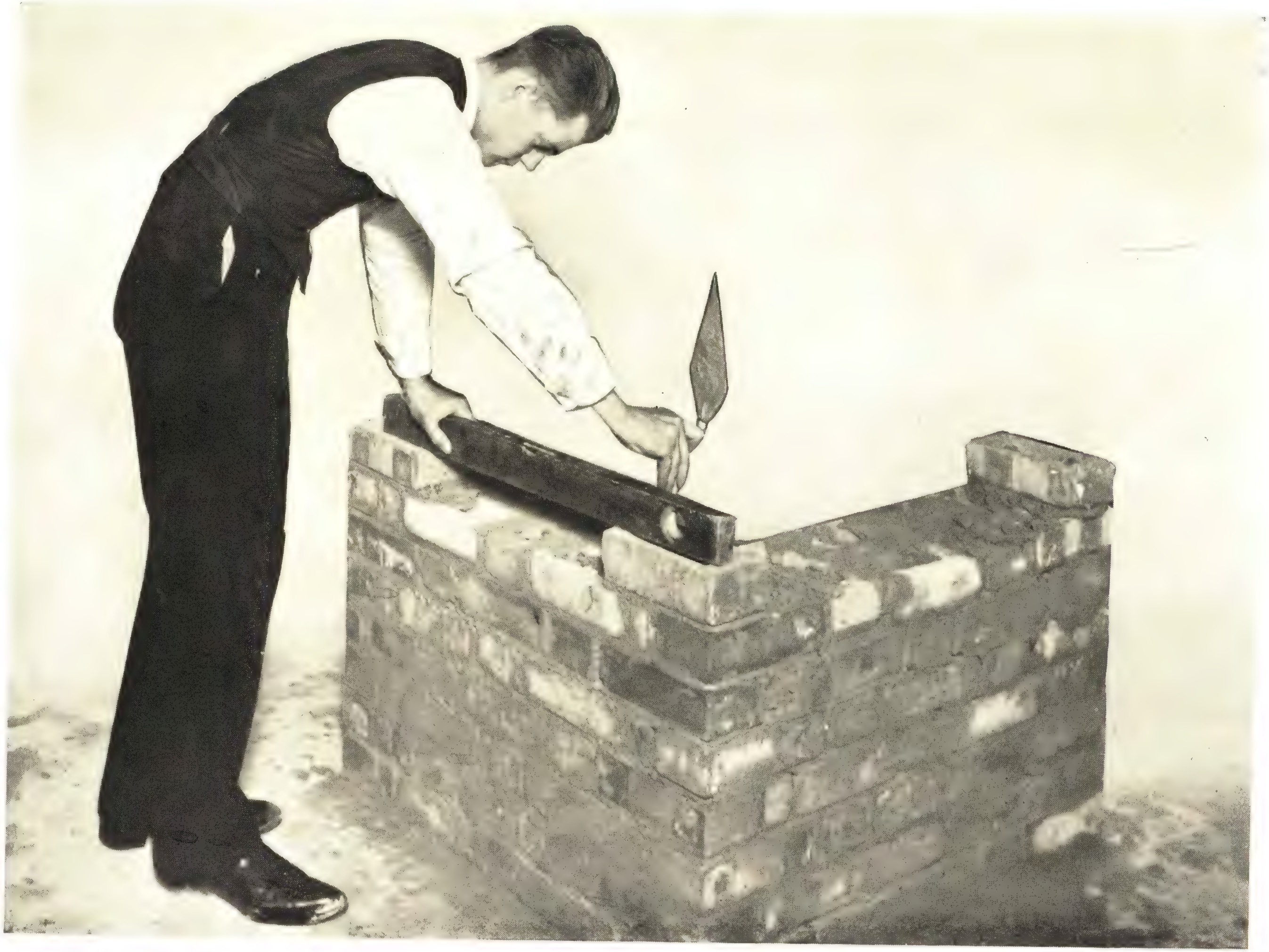
FIG. 162.

Fig. 162 shows the second course of the plan at the corner of a two and a half brick wall in single Flemish bond. The external face consists of the corner stretcher, with header next to it, which recedes into the wall three-quarters of a brick in length, and then stretcher (header on face which is a bat or half brick) and header alternately along the course, thus completing 4½ inches of the external face of wall. The return external face starts with the corner header, next to it the closer, then stretcher, header alternately all along the course. Additional stretchers are placed behind the face stretchers, thus forming the face 9 inches of the return external face. The stop end consists of four headers and two closers, forming the two and a half bricks in width on the face of the stop end of the wall. The internal face consists of a course of headers, the end one being reversed to a stretcher at the corner of the stop end. The return internal face is a stretcher course. The internal angle stretcher ties into the wall three-quarters of its length, showing 2¼ inches on the return internal face of wall, which is the stretching course; the header in the internal angle being placed against the stretcher also in the internal angle forms the vertical joint, which is in this course the first vertical joint in the heading course on the internal face. Having got so far, this leaves in both cases 9 inches again to be filled in in the interior of the wall; these spaces are again filled in with a course of headers.

PLATE

LEVELLING WITH 3-FOOT LEVEL TO OBTAIN HORIZONTAL LEVEL FROM QUOIN TO STOP END BRICK

The quoin having been placed at the angle and the end bricks at the two stop ends, the operative is seen taking the level with a three-foot level, verifying its accuracy by means of the horizontal tube (with spirit and air-bubble). This correct position enables him to see that the level of the stop ends corresponds with that of the quoin. He adjusts the level to the base of the straight-edge by tapping the inner edge of the brick with the butt end of his trowel. The three-foot level is held on edge with the left hand. The level of the quoins and stop end bricks having been adjusted, they are plumbed with the plumb-rule for vertical position and, being found correct, the intervening gaps are filled in, and tested with the straight-edge.



LEVELLING WITH 3-FOOT LEVEL TO OBTAIN HORIZONTAL LEVEL FROM QUOIN TO STOP END BRICK.

Fig. 163 shows the plan at the corner of a three-brick wall, first course in single Flemish bond. The external face consists of the corner stretcher, then header and stretcher alternately along the course, which again terminates in the stop end. All the headers as shown on this external face, it will be noticed, recede back from the face of the wall three-quarters of a brick. This form of construction is adopted so as to form the correct internal bond of the wall. The return external face of corner starts with the corner header, next to it the closer, and then stretcher, header alternately along the whole course. Again, internal stretchers are placed at the back of the return face stretchers to form the external 9 inches of this wall. The internal face consists of the stretching course, but necessitates a broken bond, for which, as will be noticed, the three-quarter brick which forms the face header is placed between the two internal face stretchers. At this point where the broken bond occurs four three-quarters form the bond across the whole width of the wall; the stop end, being a course of headers, shows five headers and two closers on the stop end face of wall. The return internal face again is a heading course; half of the header or 2¼ inches of it ties into the internal angle of the wall. This being placed against the internal angle stretcher it forms the vertical angle joint in the internal stretching course. The space which remains between the return external 9 inches of the wall and the internal return 9 inches is filled in with a heading course, thus completing the three-brick wall in width. The same method is adopted in the 9-inch space between the external and internal face of wall, and consists of four headers, which form two header courses next to the four three-quarters.

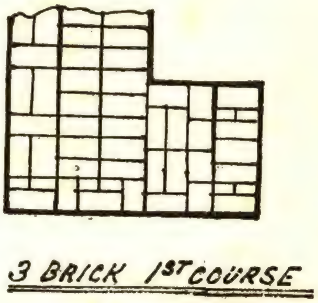


FIG. 163.

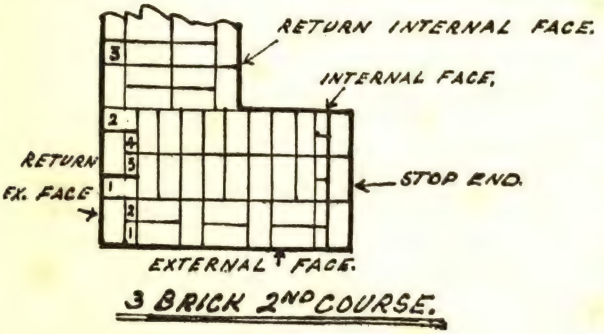


FIG. 164.

Fig. 164 shows the plan of the second course at the corner of a three-brick wall in Flemish single bond. The external face course, which in this case is indicated with arrow mark, consists of the corner header, face closer, backed with interior closer; next to it is the stretcher, and then follow header, stretcher alternately along the course. The stretchers along this course are also backed up with internal stretchers. This forms the 9-inch external part of wall. The stop end consists of three stretchers on the stop end face of wall; next to them are six closers, forming the width of three bricks across the wall. These are sometimes substituted by three queen closers instead of the six ordinary closers. The return external face is also indicated by the arrow mark. This consists of the corner header, next to it the header, and then stretcher, header alternately along the whole course. The two three-quarters which recede inwards from the face of the wall are marked 1 and 2. Farther along the course, a bat or half brick is placed to form the bond. The internal face is composed of headers from the stop end closer in the course, to the three-quarter, which is marked 2. There remains an internal 9 inches to be filled in, between the external face 9 inches and the internal face 9 inches, which is done with a course of headers also running from the closers at the stop end of wall, to the closer marked 3 and three-quarter marked 1 at the return external face of wall. The stretcher in the internal angle, which is placed against the internal angle face header, forms the vertical internal angle joint in the stretching course of the return internal face. The internal angle header ties into the wall $2\frac{1}{4}$ inches. These are the various walls which one should be acquainted with in various buildings built in single Flemish bond.

Angles in Double Flemish Bond.—The next bond to be described will be the double Flemish bond.

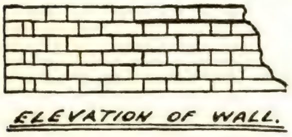
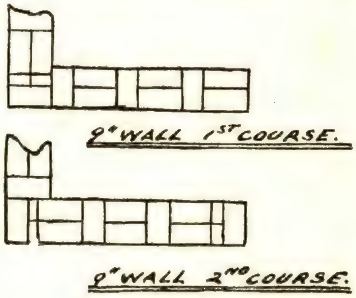


FIG. 165.

Fig. 165 shows the elevation of a wall built in double Flemish bond. It should be mentioned the arrangement, either in single or in double Flemish bond, shows exactly the same in elevation. First course—header, closer, stretcher and header alternately along the course. Second course—stretcher and header alternately along the course. All headers in the second course work centrally over all stretchers in the first course, and all stretchers in the second course work centrally over the headers in the first course.

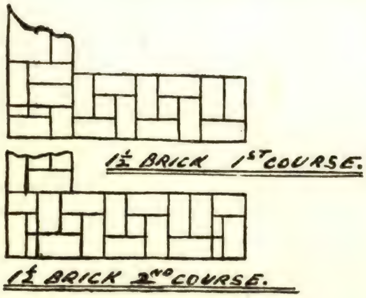
Fig. 166 shows the plan of a 9-inch corner in double Flemish bond (first course). The external face consists of the corner stretcher; next to it header and stretcher alternately along the course. The return external course consists of the corner header; next to it is placed the closer. In this case another ordinary closer is placed behind it in the interior of the wall, or a queen closer can take the place of the two ordinary closers. Next to these are placed stretcher, header alternately along the course. The internal face of this 9-inch wall consists in filling in the stretchers, which come between each header in this course. This forms the correct bond, the headers forming the external face as well as the internal face of the wall. The return internal course starts from the internal angle with three-quarters of the stretcher showing on face, the remaining quarter of this forming the tie into the internal corner. The internal vertical angle joint is the first joint in the internal face course, which is the header.

Fig. 167 shows the plan of the second course at the corner of the 9-inch wall in Flemish double bond. The external course consists of the corner header ; next to this the closer, and an internal closer behind it. Next to this is placed the stretcher, header alternately along the whole course to the stop end of the wall. The stop end in Fig. 167 consists of two headers showing on the stop end face of the wall. In this case, the stretcher is shown on the stop end face of the wall, and the closers next to it form the correct bond. The return external face consists of the corner stretcher, and placed next to this is the header and stretcher alternately along the whole course. The internal course in the internal angle starts with the stretcher which ties into the internal angle 2¼ inches, showing three-quarters of its length on the internal face. Next to this is the header which has already been laid on the external face. The other stretchers are then filled in up to the stop end of wall, finishing with closer and the header which has already been laid on the external face of the wall. The return internal face consists of the header already laid on the external return face of wall, which forms the first header starting from the internal angle ; stretcher and header then follow alternately along the course. This first header in the internal angle, which is laid against the internal angle stretcher, forms the vertical internal angle joint.



FIGS. 166 and 167.

Fig. 168 is an illustration of the plan of the first course at the corner of a one and a half brick wall in double Flemish bond. This is the standard sized wall. The external face course starts with the corner stretcher, next to it the header, which recedes into the wall three-quarters of the length of a whole brick. Next to this is the stretcher and header alternately along the course, the stretcher forming the corner brick of the stop end. The stop end shows a header and stretcher on the face. The external return face starts with the corner header. Next to it the closer, which has an internal closer behind it. Then follows stretcher and header alternately along the whole course. The internal face course starts with the internal angle header ; then stretcher, header along the course alternately, until we get to the stop end of wall, which is composed of two headers at the end of the internal face course. These two headers on the end of the course on the internal course work sectionally with the stretcher at the stop end of the external face course. The internal face return course, which starts with headers in the internal angle, is tied into the wall 2¼ inches. This being placed against the internal angle header, forms the vertical internal



FIGS. 168 and 169.

angle joint in the internal face course. Stretcher, header follow alternately from the internal angle header in the return internal face course. In this one and a half brick wall, the headers in the internal face, and placed against the back of the first half of the stretchers, are in the external face of wall, and the second half of the stretchers in the internal face of wall are placed against the back of the headers in the external face of wall, thus leaving a space internally between the back of the second half of the stretcher in the external course and the back of the first half of the stretcher in the internal face course. These spaces are filled in with bats or half bricks at intervals of 9 inches throughout the 4½-inch interior length of the wall.

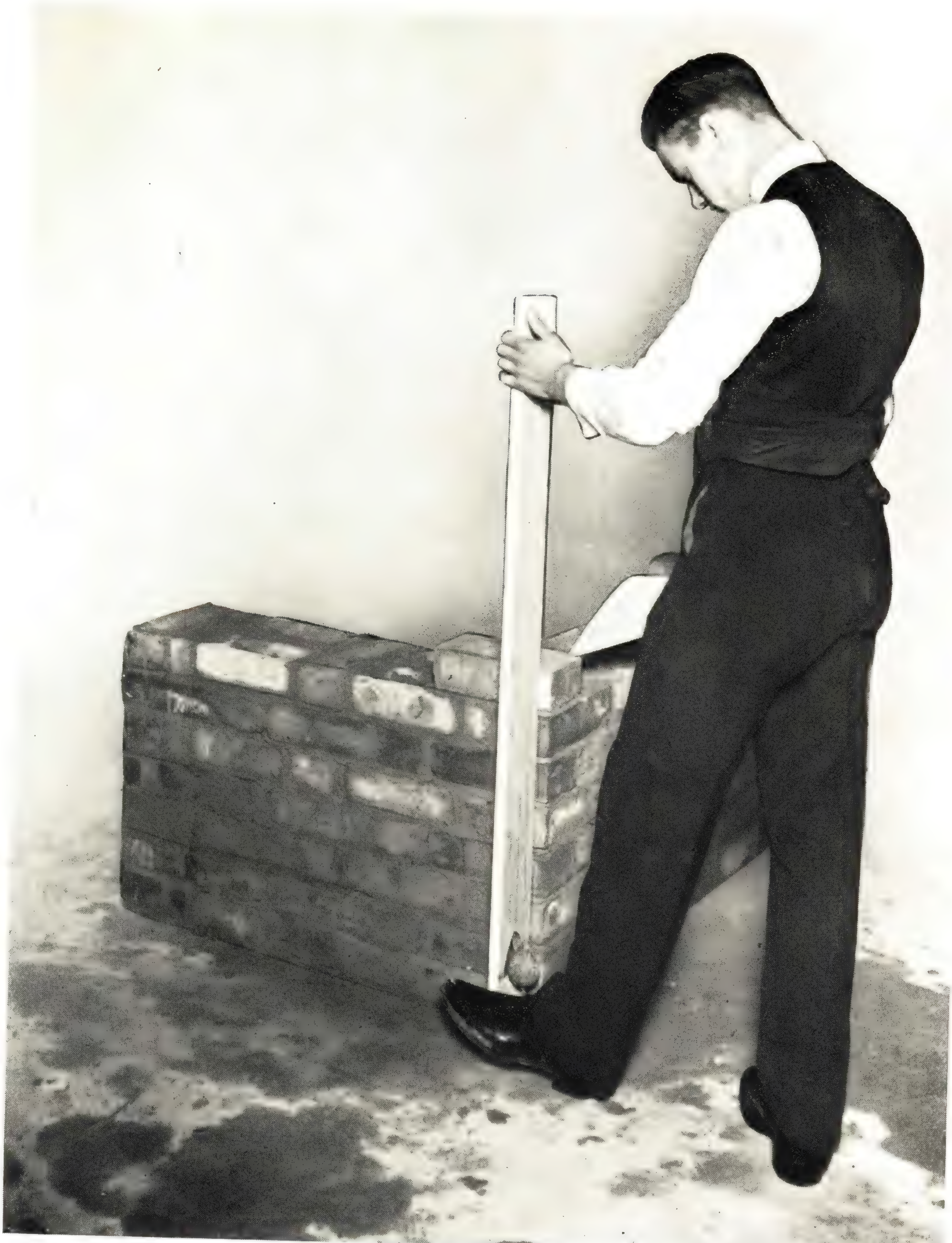
Fig. 169 shows the second course of the plan of the one and a half brick wall in double Flemish bond. The external face starts with the corner header. Next to it the closer is backed up internally by another closer. Next to this is the stretcher and header alternately all along the course until we come to the stop end of the wall. This time, on the external face, we have the closer and header, showing a stretcher and a header on the stop end face of the wall. The return external face of the corner starts with a stretcher and then follows on with a header. This recedes into the wall from the face three-quarters of the length of a brick ; stretcher and header then follow alternately all through the course. The internal face starting from the internal angle begins a stretcher, showing three-quarters on the internal face, and tying into the wall 2¼ inches. Header, stretcher, two headers and a three-quarter complete this course to the stop end of the wall. The header on the return internal face, starting from the internal angle which is placed against the internal angle stretcher, forms the vertical internal angle joint in the return internal face course of the wall. The bats or half bricks are placed in the interior part of the wall as in the first course.

Fig. 170 illustrates the plan of the first course of a corner of an 18-inch or two-brick wall in double Flemish bond. The external face course consists of the corner stretcher ; next to it the header which recedes into the interior of the wall three-quarters of the length of the whole brick ; next stretcher, header alternately along the course to the stop end. The second and third header along this course are whole bricks ; being laid crosswise they form half the width of the wall. The external return course starts with the header ; next to it the face closer backed by the ordinary closer. Then follow stretcher, header alternately throughout the course. The internal face course, starting from the internal angle, starts with a bat or half brick, next to this is a header, so in the case of this wall we have two headers showing together on the face of the wall, then follow stretcher, header, stretcher, the last stretcher forming the corner brick of the stop end. The return internal face course starts in the internal angle with the header, which ties into the wall 2¼ inches. Then follow stretcher and header alternately all through the course. The internal angle header placed against the internal angle bat forms the

PLATE

PLUMBING FOR CORRECT POSITION OF QUOIN WITH PLUMB-RULE AND LEAD-BOB

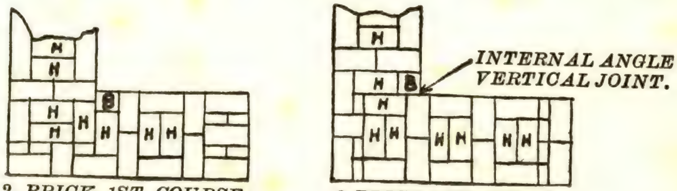
The wall seen in the two preceding plates is being plumbed for vertical position. The operative holds the plumb-rule in his left hand flush against the face of the wall about 1 inch back from the angle, the top slightly inclined towards him, the base held in position by the left foot. The line and lead-bob should swing freely through the slit and hole in the rule, showing that the wall is vertically plumb or level. This is repeated on both faces on the external and internal angles. The trowel is held in the right hand ready for any slight adjustment by light tapping with the butt end of the handle.



PLUMBING FOR CORRECT POSITION OF QUOIN WITH PLUMB-RULE AND LEAD-BOB.

internal vertical angle joint in the internal face course. The face of the stop end of the wall shows three headers and two closers. The internal parts which are required to be filled in are all headers, as shown in illustration, and are marked with an H.

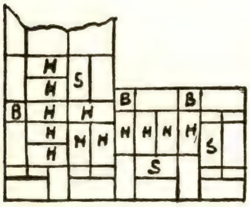
Fig. 171 is the second course of the plan of a corner of an 18-inch wall in Flemish bond. The external face course starts with the corner header and next to it the closer, which is backed up by the ordinary internal closer. Next follows the stretcher, next the header, then stretcher, header and stretcher, and the closer and header, the last named forming the corner brick of the stop end. The return external course starts with the corner stretcher, and then follow header and stretcher alternately through the course. The header which is placed next to the corner stretcher recedes into the wall three-quarters of the length of a whole brick. The internal face course consists of the internal angle header, which ties into the wall 2¼ inches. Next comes the stretcher, header, stretcher, closer and header, which forms the corner stop end brick. The internal return face course starts from the internal angle with the bat or half brick which is marked B. Then follow header and stretcher alternately along the course. The spaces which require filling in in the internal part of the wall are filled in with headers as marked. The internal angle vertical joint is also marked. The stop end consists of two stretchers showing on the stop end face of the wall.



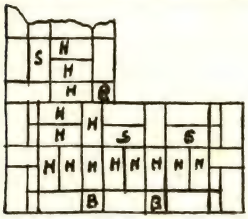
2 BRICK 1ST COURSE. 2 BRICK 2ND COURSE.

FIGS. 170 and 171.

Fig. 172 shows the plan of the first course of a corner of a two and a half brick wall in double Flemish bond. I may mention here that the walls which contain an odd half brick in the thickness contain bats or half bricks, whereas the walls which contain a number of whole bricks in width consist of practically all whole bricks. In the case of the one and a half and the two and a half brick walls—in the one and a half brick wall we have a series of half bricks running throughout the length of the interior of the wall. Also, in the case of the two and a half brick wall, we have a series of bats or half bricks running throughout the face of the wall in every other course as shown in Figs. 172 and 173. So it will be understood that in double Flemish bond the 18-inch wall or two-brick wall is much stronger than the one and a half brick wall; and the two-brick wall is equally as strong as the two and a half brick wall, because the two-brick wall contains practically no bats, while the two and a half brick wall contains a larger number of face bats or half bricks. The external face course starts with the corner stretcher. Next to this come header and stretcher throughout the course to the stop end of the wall. The header next to the corner stretcher on the external face course recedes into the wall three-quarters of the length of the whole brick. The return external face starts with the corner header, a closer next to it, backed up with internal ordinary closer. Next to this are stretcher and header all through the course. The headers on this external return face course are bats or half bricks as marked with a B. The internal face course starts with a bat marked B, in the internal angle next to it a stretcher; next to this is another bat, finishing with a stretcher, which forms the corner brick on the stop end of the wall. The return internal angle consists of a stretcher which ties into the wall 2¼ inches. This is placed against the internal angle bat B, and forms the internal angle vertical joint in the internal face course. From this internal angle stretcher, the bond consists of header and stretcher alternately throughout the return internal face course. The stop end consists of two headers forming the corner stop end face bricks. Next to these are the closers, and a stretcher in the centre. This completes the width of the wall, viz. two and a half bricks. The bricks which are required to fill in the interior space are marked, viz. H for headers and S for stretchers.



2½ BRICK 1ST COURSE.

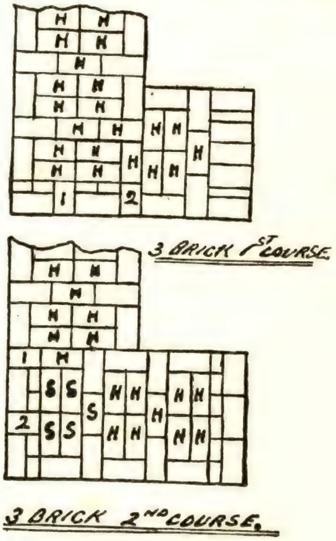


2½ BRICK 2ND COURSE.

FIGS. 172 and 173.

Fig. 173 shows the second course of the plan of a two and a half brick wall in double Flemish bond. The external face course consists of the corner header; next to this is placed the closer, which is backed up by the internal ordinary closer; then we have stretcher and header alternately through the course until we again reach the stop end of the wall. This consists of the corner stop header with the closer placed next to it. The return external face course starts with the corner stretcher; next to it the header and stretcher following alternately along the course. The header which is next to the corner stretcher recedes into the interior of the wall three-quarters of the length of the whole brick. The internal face course starts with the internal angle stretcher which ties into the wall 2¼ inches, showing three-quarters of the length of the brick on the internal face course. The header is placed next, stretcher next, closer next, and then the header forming the corner stop end header, which shows a stretcher on the stop end face of wall. The stop end face is composed of two stretchers which form the two corners, and a header in the centre of them, thus forming the two and a half bricks in width. The return internal face course starts with a bat or half brick and stretcher and header follow alternately along the internal return face course. This bat, which is placed against the internal angle stretcher, forms the vertical internal angle joint, which is in the return internal face course. The internal bricks to be filled in are marked in this course H for headers and S for stretchers.

Fig. 174 shows the plan of the first course of a corner of a three-brick wall in double Flemish bond. The external face course starts with the corner stretcher, then header and stretcher follow alternately to the end stretcher which forms the corner of the stop end. The two receding three-quarters from the external face course are marked 1 and 2. The return external face course starts with the corner header; next to it is placed the closer backed up with an internal ordinary closer; then follow stretcher and header alternately through the length of the course. The internal face course consists of internal angle stretcher; next to it the header, and following another stretcher which forms the corner stop end brick. The return internal face course starts with the internal angle stretcher, which ties into the wall three-quarters of the length of a whole brick, showing one-quarter of its length, or 2¼ inches in the return internal face course. Next to this is the header and stretcher alternately through the whole course. The internal return face angle stretcher being placed against the angle stretcher of the internal face course forms the internal angle vertical joint in the internal face course. The stop end face of wall consists of five headers and two closers, which show on the stop end face of the wall. The internal spaces which are required to be filled in are marked H for headers and S for stretchers. It will also be seen where the internal closers are to be filled in, in the interior of the wall.



FIGS. 174 and 175.

Fig. 175 shows the plan of the second course of the corner of a three-brick wall in double Flemish bond. The external face course consists of the corner header with closer next to it, backed up by an internal ordinary closer; then stretcher and header alternately till we get to the closer and the header which form the corner stop end brick. The return external course starts with the corner stretcher; then comes header and stretcher alternately through the course. Nos. 1 and 2 headers on the external return face recede into the interior of the wall three-quarters of a brick in length. The internal face course starts with the internal angle stretcher, which ties into the wall three-quarters of its length, 2¼ inches, or the remaining quarter of the length of the brick showing in the internal angle on the internal face course. Next to this is the header; then the stretcher; next closer, and then another header forming the corner stop end brick, which shows as a stretcher on the stop end face of wall. This stop end face of wall shows three stretchers, which form the width of the wall. Behind these three stretchers are six closers, or three queen closers could substitute for these. The return internal face course starts with the internal angle stretcher which is placed against the internal angle stretcher in the internal face course. This forms the vertical internal angle joint in the return internal face course. Next to the return internal angle stretcher, the headers and stretchers run alternately throughout the length of the course. The internal headers which are required to be filled in in the interior parts of the wall are again marked with the letter H. Stretchers are also marked with the letter S.

English Bond Details.—Referring back to the preceding figures it will be seen that Fig. 172 shows the plan of two courses in English bond with stop ends to the walls. These have been previously explained with the corners of the walls attached.

Fig. 173 shows the plans of two courses, the first and second course of two stop ends. The first course shows a header on the corner of the stop end; next to it the queen closer and then headers all through the course. At the back of this course of headers there is a row of stretchers all whole bricks. The first brick on the corner of the stop end should be a three-quarter instead of the stretcher, and then the bricks at the stop end would work in sectional bond, that is to say, the three-quarters on the internal face stop end would work sectionally with the header and closer external face stop end. But the method as shown is wrong, because such a bond is very weak and defective. The thick lines on the plans of the two courses show the internal joints which occur.

Fig. 174 shows the plans of the two stop ends of the two courses of the two-brick wall in English bond, showing three headers and two closers on the face stop end in the first course, as well as the two courses of stretchers, one external face and the other internal face of wall, with a row or course of internal headers. The second course shows two stretchers on the face stop end, which form the first headers or corner headers. Next to these are two closers; then follow the course of headers internally and externally along the course.

Fig. 175 shows the first and second courses of the stop end plans of the two and a half brick walls. Stop end face of first course shows two stretchers at either corner, and a three-quarter in the middle. Next to the corner headers in the internal and external course is placed the queen closer; next to these on the internal face of wall is a course of stretchers, and on the external face is a row of headers. The remaining 9 inches internal space which has to be filled in is composed of another row of headers, making the two and a half bricks in width. The second course stop end face consists of four headers and two closers. On the internal face next to the stop end corner stretcher, a row or course of headers is placed, the external face consisting of a course of stretchers. This again is filled in with a course of internal headers, which makes up the remaining 9 inches in the width of the wall, Fig. 176 shows the first and second plans of the courses of a stop end wall three bricks in thickness in English bond. The stop end face of the first course consists of five headers and two closers. The internal and external faces of the wall consist of stretchers along the whole course. The internal space of 18 inches is filled in with two heading courses, thus making the wall three bricks in width. The second course stop end face consists of three stretchers. The corner stop end bricks form two headers which start the internal and external faces. Closers are placed next to these, and then a course of headers along the course internally and externally. The interior 9 inches of space is filled in with another course of headers. This again forms the width of the wall, which is three bricks wide.

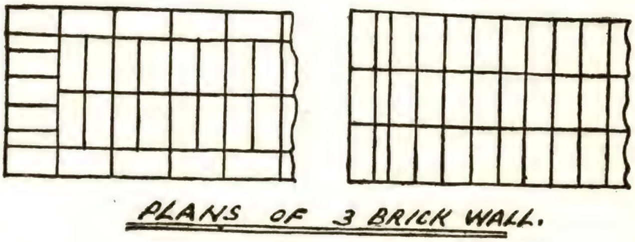


FIG. 176.

Fig. 177 shows the plan of the first course of a one and a half brick wall in English bond with broken transverse joints. This means that the transverse joints which run from the face of the wall or external face to the internal part of the wall, or the internal face, are not continuous but are broken. In such a case, the cross joints in the external stretchers face course in the first course only proceed into the interior of the wall $4\frac{1}{2}$ inches, whereas if the bond were laid sectionally, the cross joints would extend through the whole width of the wall from the external to the internal face. The external face course starts with the corner stretcher, and then stretchers follow all along the course. The return external face course starts with the corner header. Next to it is the closer, and then headers all along the course. The internal face course starts with the internal angle header, which is tied into the wall $2\frac{1}{4}$ inches, and then headers follow all along this course. The internal return face course starts with the internal angle stretcher, and then stretchers follow all along the course. The internal angle cross joint is formed by the internal return angle stretcher being placed against the internal angle header. This cross joint shows in the return angle internal face course, which is the stretching course. The space between the internal angle header and the second and third headers on the external face return course is filled in with two closers.

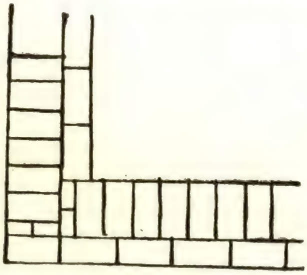


FIG. 177.

Fig. 178 shows the plan of the second course of the one and a half brick wall, also with broken transverse joints. The external face course consists of the corner header, followed by the closer, which is backed up by another closer behind it in the interior of the wall. Then headers follow all along the course. The return external face consists of the corner stretcher followed by the stretching course composed of all stretchers. The internal face course is composed of the internal angle stretcher, and then stretchers follow all along the course. The return internal face course starts with the internal angle header which ties into the wall 2¼ inches, having two closers next to it in the interior of the wall. From the internal angle headers follow all headers along the course. The internal angle cross joint in this case is at the end of the internal angle face stretcher, which is placed against the internal return angle header.

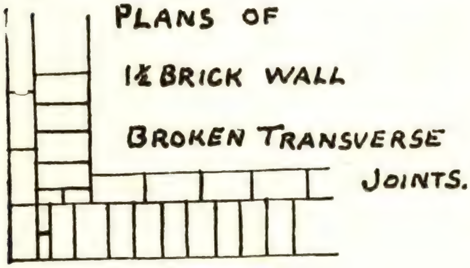


FIG. 178.

Fig. 179 shows the plan of a course of the 18-inch wall or two-brick wall with broken transverse joints in English bond. The external face course starts with the corner stretcher, following which is a course of stretchers. The return external face course consists of the corner header. Next to it is the closer backed up by another internal closer. Then headers follow all along the whole course. The internal face course consists of a course of stretchers, and the internal return face course consists of a course of headers, starting with a header from the internal angle of the wall. This bond is also very weak and defective. The internal angle in this case is very weak and with this bond forms a straight joint in the internal angle, besides which it forms a large number of internal vertical straight joints, and therefore is not used in good construction. The straight joint in the internal angle can be removed by placing the internal angle stretcher to the left, and tying into the wall 4½ inches as shown by the dotted lines. In the next course this stretcher can be reversed in the internal angle and tied into the wall three-quarters of its length.

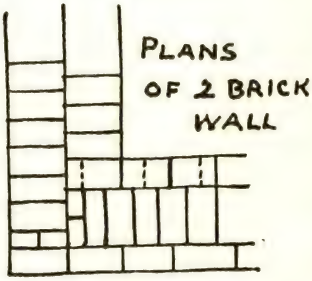


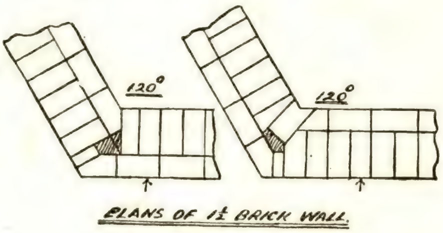
FIG. 179.

ACUTE AND OBTUSE ANGLES

We may now pass on to a consideration of walls which have acute and obtuse angles. First we will take the English bond, and then the Flemish bond.

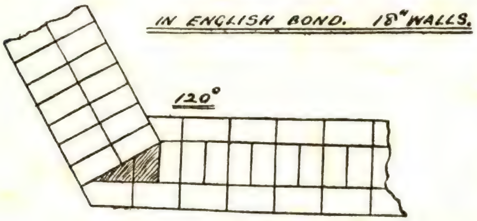
In English Bond.—Fig. 180 shows the plan of the first course of a wall which is built at the angle of 120 degrees (obtuse angle) 14 inches in thickness. The external face of this angle in English bond, as indicated by arrow, starts with a squint quoin brick. This is about 6¾ inches to 7 inches on the stretcher face. Next to this follow all stretchers throughout the course. The return external face starts with the 2¼-inch return face of the squint quoin brick. Next to this is placed the closer, then follow headers throughout the course. The internal face course starts with the internal angle header, and then follow headers throughout this course. The return internal face course starts with the internal angle brick, which in this case shows three-quarters of the length of a brick on the face, the remaining portion of it being splayed off, and fits against the internal angle header in the internal face course. This forms the internal angle vertical cross joint. The remaining bricks on the return internal course are stretchers.

Fig. 181 shows the second course of the 120 degrees obtuse angle of a 14-inch or one and a half brick wall in English bond. The external face course starts with the squint quoin brick, showing 2¼ inches on external face course. Next to this is placed the closer, and then follow headers all through the course. The external return face course starts also with squint quoin brick, showing about six and three-quarters on face. Stretchers follow all along the course. The internal face course consists of a stretching course or a course composed of stretchers. The internal return face course consists of a course of headers, with the exception of the closer which is placed next to the internal angle header. This header is so shaped to show half of the width of its face on the internal face course, and the other half of the width of its face on the internal return face course. This type of internal angle header is called a bird's-mouth, and is cut to the required angle of 120 degrees. This brick is placed in every other course in the internal angle, and covers the internal angle cross joint in the course below it. The shaded portions in the internal parts of the wall are shaped pieces of bricks placed in position to complete the internal bond of the wall. Sometimes these voids are filled in with mortar or whatever material is being used; sometimes with pieces of small brick, but this should not be done, as it weakens the wall and does not form the correct internal wall joints. Internal joints are of as much importance as joints that can be seen externally, and should always be properly constructed.

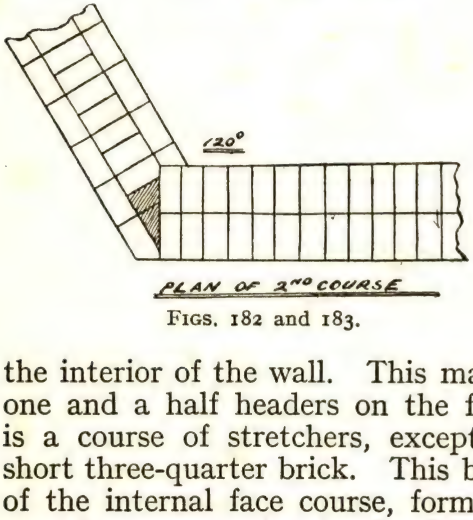


FIGS. 180 and 181.

Fig. 182 shows the plan of the first course of the 120 degrees obtuse angle of a two-brick wall in English bond. The external face course consists of a course of stretchers except the external angle brick, which is a squint quoin brick, showing three-quarters of the length of a brick on the stretcher face course. The return external face course consists of a course of headers. The squint quoin brick also shows as a header or the return in this course. The internal face course consists of a course of stretchers except the internal angle brick in this course, which is a short three-quarter brick. The internal 9 inches between the external face course and the internal face course is filled in with a course of headers which makes up the correct width of the wall, which is two bricks wide. The internal face return course is composed of all headers, which tie into the wall at the internal angle one and a half headers. This brings the internal return face headers sectionally with the external return face headers. The internal angle cross joint is formed by placing the internal angle three-quarter in the stretching course against the internal angle header in the heading course. It is then in position as the first cross joint at the angle in the stretching course of the internal face course. The shaded portions in the figure are the bricks which are shaped to fill in the spaces in the interior of the wall.



PLAN OF 1ST COURSE



PLAN OF 2ND COURSE

FIGS. 182 and 183.

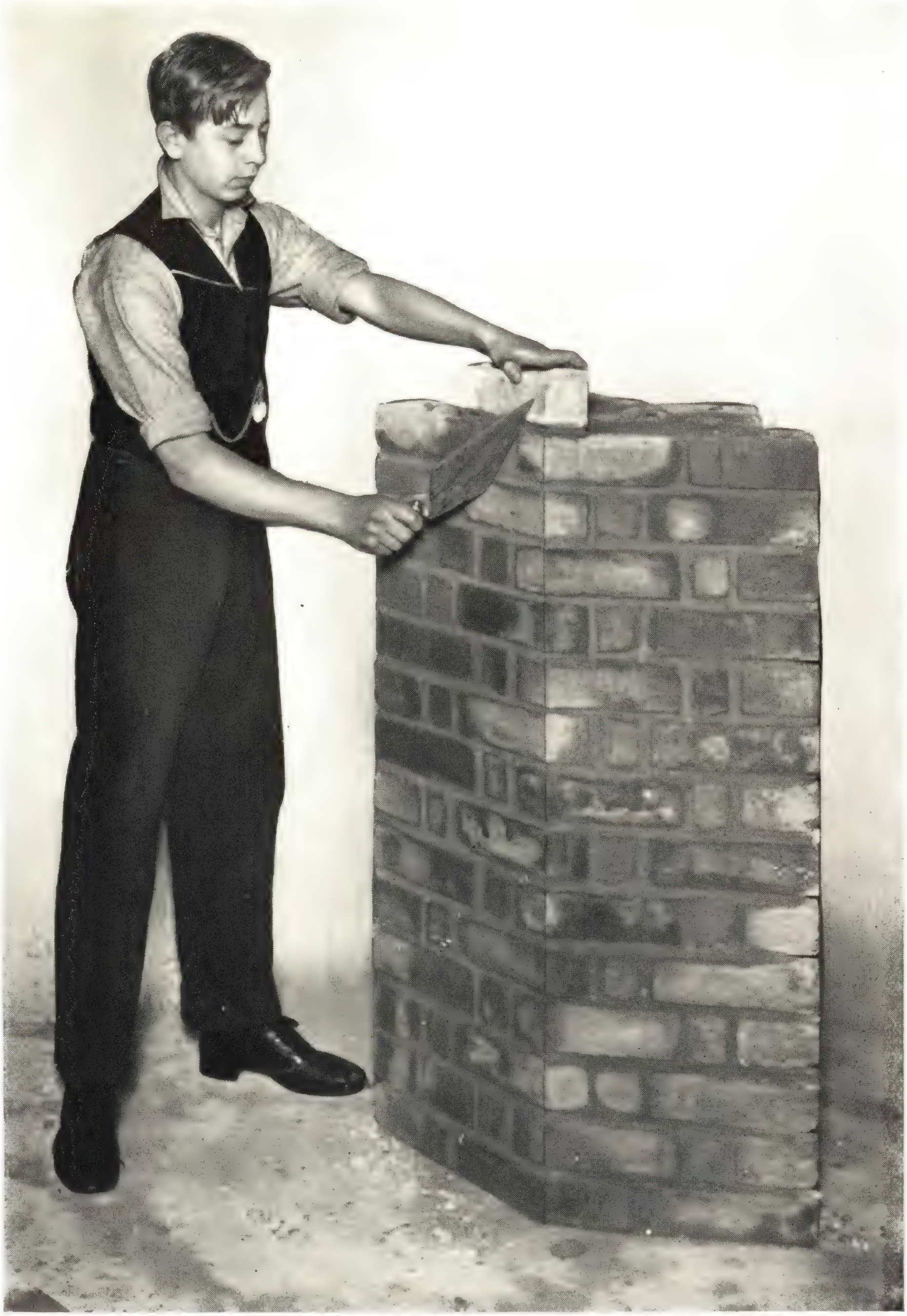
Fig. 183 shows the plan of the second course of the 120 degrees obtuse angle of a two-brick wall in English bond. The external face course consists of a course of headers. The squint quoin brick also shows a header in this course. The external return face course is a course of stretchers, the return face of the squint quoin brick showing a three-quarter in this course. The internal face course consists of a course of headers. The internal angle header ties into the wall 2¼ inches. There is also one more header beyond that into the interior of the wall. This makes the tie into the wall the length of one and a half headers on the face. The return internal face course is a course of stretchers, except the internal angle brick, which is a short three-quarter brick. This brick, being placed against the headers of the internal face course, forms the internal angle cross joint in the stretcher course, that is, the internal return face course. The shaded portions as shown are the shaped pieces of brick required to form the correct internal bond.

Fig. 184 shows the plan of the first course of an acute angle of a one and a half brick wall in English bond. The external face course starts with the corner splay brick, which shows a header in this course. Next to it is the closer, and then headers follow throughout the length of the course. The external return face course is composed of all stretchers including the corner splay brick. The internal face course consists of

PLATE

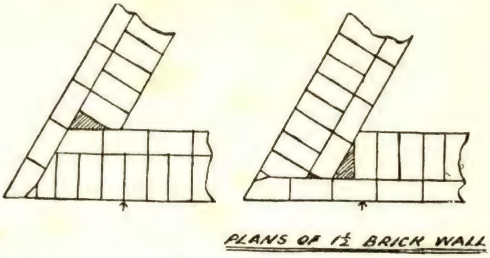
CONSTRUCTION OF A SQUINT PIER

A squint pier on which the operative is bedding a squint quoin in position. Such a pier besides being tested for vertical position should be plumbed on the two reveals, the external faces on each side of the quoin and at the angle point.



CONSTRUCTION OF A SQUINT PIER.

a course of stretchers. The internal angle stretcher ties into the wall 2¼ inches or a quarter of the whole length of the brick. The internal return face consists of all headers. The internal angle header in this course has a small corner cut off so as to allow it to be placed nearer to the internal angle, by which means it forms the correct sectional bond with the external return face course, which is the stretcher. This cut internal angle header, placed against the internal angle stretcher, forms the internal angle cross joint which starts the return internal face course, which are headers.



FIGS. 184 and 185.

Fig. 185 shows the plan of the second course of the acute angle of a 14-inch wall in English bond. The external face course consists of the corner splay brick, which shows a stretcher, and following this, stretchers are laid all through the course. The return external face course consists of the splay corner brick, which forms the header. Next to it is the closer, and following this, headers all along the course. The internal face course consists of all headers, except the internal angle header in this course, which has a corner splayed off, as in Fig. 184. The internal return face course starts with the internal angle stretcher, and following it, all stretchers along the course. This internal angle stretcher, being placed against the internal angle headers, forms the first internal vertical joint in the internal heading face course. The bricks which are shaded are the portions to be filled in to form the bond.

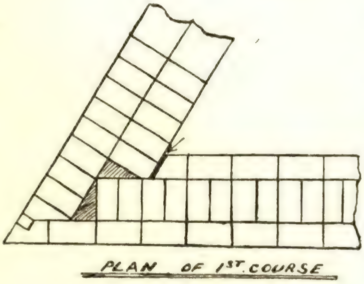


FIG. 186.

Fig. 186 shows the first course of a plan of the acute angle of an 18-inch or two-brick wall in English bond. The external face course consists of the corner splay brick, which shows as a stretcher in this course followed by stretchers throughout the course. The external return face course consists of the corner splay brick, which is the header in this course, followed by the closer placed next to it, and then all headers throughout the course. The internal face course contains all stretchers, except the internal angle brick in this course, which is a bat or half brick on the face. This is splayed at the end to fit into position against the internal return face course, composed of headers. The internal angle header ties into the wall 2¼ inches, and one header is also placed beyond this to form the proper sectional bond with the external return face heading course. The internal angle vertical cross joint is the first joint in the internal face course, which are stretchers. The shaded portions are the shaped pieces of bricks required to be placed in the interior of the wall to form the proper bond. This is shown in all the other examples.

Fig. 187 shows the plan of the second of an acute angle of an 18-inch or two-brick wall in English bond. The external face course consists of all headers, with the exception of the closer, which is placed next to the corner splay brick showing as a header on this face. The return external face course shows all stretchers through the course. The internal face course is all headers. The internal angle header ties into the wall 2¼ inches. There is another header placed in position beyond this, which has a small portion of the corner taken from it. This is done to bring it in sectional line with the headers which are in the external face course. This is indicated by the arrow mark. The return internal face course is composed of stretchers, except the internal angle return brick, which in this case is a short three-quarter brick on the face. This is splayed and placed in position against the internal angle headers in the internal face course, which ties into the wall. This forms the internal angle vertical cross joint in the internal return face course. This is indicated by the arrow mark in the internal angle and also marked with the thick line to represent the internal angle vertical cross joint. Fig. 186 is also marked in the same manner as this.

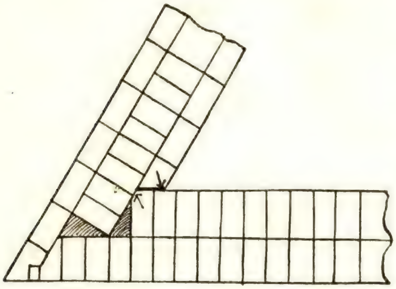


FIG. 187.

We will now take one or two examples in obtuse and acute angles in double Flemish bond.

Fig. 188 shows the plan of the first course of a 120 degrees obtuse angle of the one and a half brick wall in Flemish bond. The external face course consists of the corner squint quoin brick, which shows 2¼ inches on the face. Next to it is the closer, and then follow stretchers and headers alternately along the whole course. The external return face course starts with the squint quoin brick again, this time showing a three-quarter of the length of a whole brick on the face. Then follow headers and stretchers alternately all along the course. The internal face course starts with the internal angle brick, which is shaped and shows 2¼ inches on the face. Next to it follows the stretcher and header alternately along the course. The internal return face course starts with the internal angle brick, which is shaped and splayed internally, and shows about 4½ inches on the face. Next to it follows the header, and then stretcher alternately along the course. The shaded portions show the bats or half bricks and also the angular-shaped

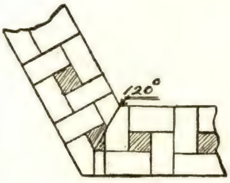


FIG. 188.

portions of brick which are required to fill in the interior 4½ inches internal portion of the wall. The internal angle vertical cross joint is exactly in the angle between the internal angle shaped bricks, as indicated by the arrow mark.

Fig. 189 shows the plan of the second course of a 120 degrees obtuse angle of the one and a half brick wall in double Flemish bond. These angles are usually formed in either English or double Flemish bond. If the one and a half brick wall were composed of single Flemish bond, it would entail the use of a great number of bats on the external face course, and would therefore be very weak. This is not usually done in obtuse or acute angles. The external face course consists of the squint quoin brick, which shows the three-quarter on this face. Then follow headers and stretchers alternately all along the course. The return external face course starts again with the squint quoin brick. Next to it is placed the closer; then follow stretchers and headers alternately all along the course. The internal face course starts this time with the internal angle brick, which shows the large part of the width of its face in this course, and the smaller portion in the internal return face course. This is a shaped brick known as a bird's-mouth. These two points are indicated by arrow marks. These two face lengths of the internal angle brick will be guided by the bond in the internal angle in the first course. Headers and stretchers follow from the internal angle bird's-mouth alternately through the internal face course. The internal return face course starts with the smallest width of the face of the internal angle brick, which is the bird's-mouth. Then follow stretchers and headers alternately all along the course. The internal pieces again required to be filled in are shown by the shaded portions.

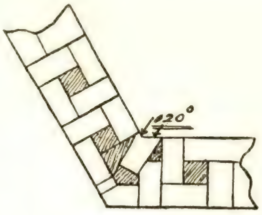


FIG. 189.

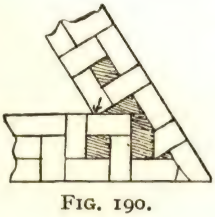


FIG. 190.

Fig. 190 shows the plan of the first course of an acute angle of a one and a half brick wall in double Flemish bond. The external face course consists of the corner brick, which is a splay brick, showing 9 inches on the face. Then follow headers and stretchers alternately along the course. The return external face course consists of the splay corner brick, which shows as a header on this face. Next to it is the closer, which is of a triangular shape, owing to the position of the splay corner brick and the stretcher, which is placed next to the closer: After the closer are placed stretchers and headers alternately all through the course. The internal face course consists of the internal angle stretcher, which has a small part of the corner cut from it as indicated by arrow. Then follow headers and stretchers alternately along the course. The internal return face course starts with the internal angle stretcher. This is tied into the wall about three-quarters of the length of a brick, showing

2¼ inches on the face from the internal angle. Next to this follow the headers and stretchers alternately all along the course. The internal angle stretcher as indicated by arrow mark, placed against the internal angle stretcher which is tied into the wall, forms the internal angle vertical cross joint in the internal face course.

These internal angle joints are very important, and should be correctly formed, otherwise if a series of straight joints occur, or there is improper bonding in the internal angle, weakness is caused in the angle just where strength is most required.

The shaded portions in the diagram again indicate the various portions of shaped bricks and half bricks which are required to be filled in in the interior portion of the wall to form the correct bond.

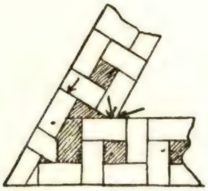


FIG. 191.

Fig. 191 shows the plan of the second course of an acute angle of a one and a half brick wall in double Flemish bond. The external face course starts with the corner splay brick, showing 4½ inches on the face ; next to it the closer, which is angular in shape. Next follow stretchers and headers alternately all through the course. The external return face course starts with the splay corner brick, which is a stretcher on this face. Then follow headers and stretchers alternately all through the course. The internal face course starts with the internal angle stretcher, which ties into the wall three-quarters of the length of a brick, 2¼ inches showing on the face in the internal angle of the internal face course. Next follow headers and stretchers alternately all along the course. The internal return face course starts with the internal angle stretcher. This has a corner removed as indicated by the arrow, so as to form a sectional bond with the header on the external return face course, as also shown by arrow indication mark. Then follow headers and stretchers alternately along the course. The internal angle joint is formed and shown in the internal angle, and is the first vertical cross joint in the internal return face course. This is indicated by arrow mark also. The internal filling in is again indicated by shaded portions.

CHAPTER X

PIERS, REVEALS, AND JAMBS

Attached or Engaged Piers—Detached Piers—Square Piers in English Bond—Square Piers in Flemish Bond—Squint Piers—Reveals—Jambs.

PIERS are rectangular, oval, or circular pillars, constructed to carry a concentrated load or weight, which is sometimes transmitted to them by girders, beams, etc. Piers may be built attached to a wall or they may be detached and stand alone.

Attached or Engaged Piers.—In the case of the piers which are attached to a wall, the bond which is used in the pier is practically the same as the bond used in the wall. These attached piers are built in various lengths and thicknesses on the face of the walls ; a common size for a garden or boundary wall pier being 4½ inches by 14 inches, or 4½ inches by 18 inches ; that is, the pier would be 4½ inches projection from the face of the wall, and 14 inches or 18 inches long on the horizontal face of the pier. Where extra strength is required they project 9 inches or more from the face of the wall.

Detached Piers.—In the case of the detached piers, they are sometimes built square, and sometimes constructed of a rectangular shape. This shape could be considered a short length of wall with either square-stop end or bull-nosed ends. An example of this would be a pier constructed about 14 inches in thickness and about 3 feet in length. These piers are sometimes used between large windows in main walls of buildings. They are also built in conjunction with the main walls. At the base and also at the top portion of the pier when constructed in between window openings they become attached piers. These attached piers are invariably built in Flemish bond, to coincide with the bond in the main walls. Detached piers should always be constructed in English bond to give them the maximum strength which is required in order to carry the various loads, or thrusts. These piers should be built with as many whole bricks as possible, and where closers are necessary to form the correct bonding, and where Flemish bond is used, it being the weakest bond, queen closers should always be used instead of the ordinary closer. This makes a great difference to the strength of the pier. Good material, such as a well-burnt brick, and good mortar, whether gauged mortar or cement mortar is adopted, should be used. These two points should be studied in combination with good craftsmanship for the building of strong, sound piers.

Square Piers in English Bond.—Fig. 192 gives an isometric view of a square pier in English bond. Fig. 193 shows the plan of the first of a 9-inch square pier in English bond. This pier can only be constructed with whole bricks. As will be seen, a stretcher is shown on the face and back of the pier, the two whole bricks being laid side by side; on the left and right hand side of the pier two headers are shown.

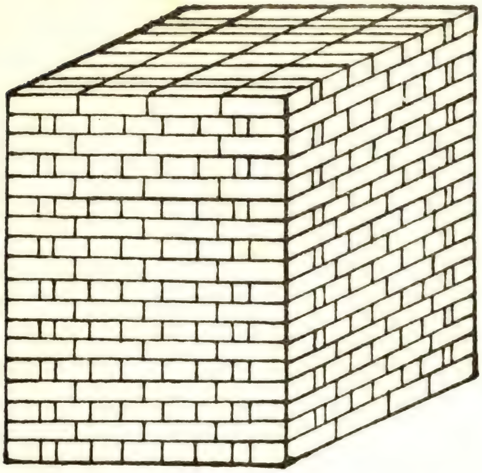
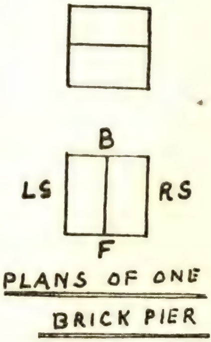


FIG. 192.

Fig. 194 shows the plan of the second course of a 9-inch square pier in English bond. This shows the two whole bricks laid the reverse way to what they are laid in the first course, thus showing two headers on the face and back of the pier and two stretchers at either side of the pier.

For the purpose of better illustrating the various bonds which are used in these piers, the 9-inch piers are marked in the second course thus: F stands for the front face course of the pier; LS the left hand side face course; RS the right hand side face course; and B the back face course. The various positions of the piers and the bond which is used in the various courses will thus be seen at a glance as we proceed.



FIGS. 193 and 194.

Fig. 195 shows the plan of the first course of a 14-inch or one and a half brick square pier in English bond. The face course of the pier consists of two three-quarter bricks, the left hand side face course header and a stretcher, the right hand face course header and stretcher also, and the back face course consists of three headers. The best bond, and also the strongest bond for the one brick and a half square pier, would be six three-quarter bricks in the first course, viz. two three-quarter bricks showing on the face course of the pier, and three headers showing at left hand side face course and three headers showing at the right hand side course, and two three-quarters showing at the back face course; in the second course again using the six three-quarters. They would be reversed on each face course of the pier. In this bond all the vertical cross joints in the first course are covered by the bricks in

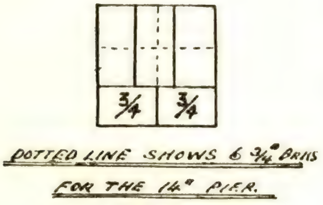


FIG. 195.

the second course. Although this bond is undoubtedly the best and strongest, it is not generally used, on account of the cutting of all the bricks in each course, so it is only used occasionally on first-class work. The dotted lines in Fig. 195 show the position of the three-quarter bricks in the course.

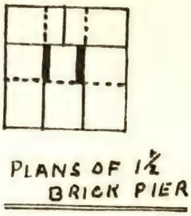
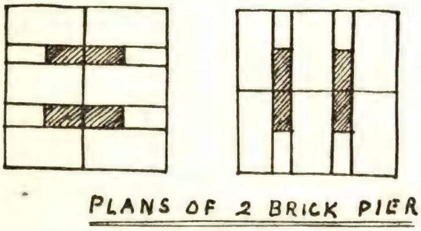


FIG. 196.

Fig. 196 shows the plan of the second course of the one and a half brick square pier in English bond. It consists of three headers on the front face course, one brick or stretcher and header on the left and right hand side faces courses, and two three-quarter bricks on the back face course. The dotted lines show the course above it in which the bricks are reversed. This bond is not so strong as the six three-quarters, as it produces two vertical straight joints in the interior of the wall which are a cause of weakness. These joints, as will be seen in illustration, are marked with thick lines.



FIGS. 197 and 198.

Fig. 197 is the plan of the first course of an 18-inch or two-brick square pier, in English bond. The front face course of the pier consists of two stretchers. The left hand side face course consists of three headers and two face closers, and the right hand side face consists of three headers and two face closers. The four internal closers at the back of the face closers are shown with shaded lines.

Fig. 198 shows the plan of the second course of an 18-inch square pier in English bond. The front face course of the pier consists of three headers and two face closers, the left hand side face course consists of two stretchers, the right hand side face course consists of two stretchers also, and the back face course consists of three headers and two face closers. The internal closers which back the face closers are shown by shaded lines.

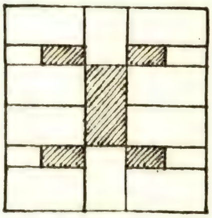


FIG. 199.

Fig. 199 shows the plan of the first course of a two and a half brick square pier in English bond. The front face course of pier consists of two stretchers, one placed at each end of the pier with header in the centre. The left hand side face course consists of header and closer at either end with two headers in the centre. The right hand side face course consists of four headers and two closers placed in the same positions as the left hand side face course. The back face course consists of two stretchers, one at either end and the header in the centre. The two headers, one which shows in the centre of the front face course and the other which shows in the centre of the back face course, recede or tail into the interior of the wall three-quarters of the length of a brick. The internal portions which require to be filled in are shown with shaded lines and include four ordinary closers and one whole brick, which works sectionally with the front and back face course headers, the perpendicular cross joints at either side of them running the whole length of the pier.

Fig. 200 shows the plan of the second course of a two and a half brick square pier in English bond. The front face course consists of a header and a closer at each end and two headers in the centre of the course. The left hand side face course consists of two stretchers, one at each end and a header in the centre of the course. The right hand side face course consists of bricks placed in the same manner as in the left hand side face course. The back face course consists of the header and closer at either end and two headers in the centre of the course. The shaded portions show the internal portions to be filled in consist of four ordinary closers, and one whole brick which is in the first course. The headers which show on the left and right hand side face courses recede or tail into the interior of the wall three-quarters of the length of a whole brick, and are marked $\frac{3}{4}$.

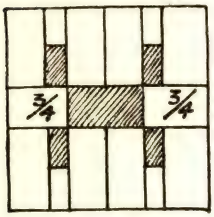


FIG. 200.

Fig. 201 shows the plan of the first course of a three-brick square pier in English bond. The front face course consists of three stretchers. The left hand side face course consists of a corner header and closer at either end of the course, and three headers in the centre part of the course. The right hand side face consists of bricks placed in the same position as the left hand side face course. The back face course consists again of three stretchers. The internal portions which require filling in are shown with shaded lines, and consist of eight ordinary closers and three whole bricks in the centre portion of the wall. Six queen closers would form the strongest work, instead of the ordinary closers, but in ordinary work the closer is generally used. The dotted lines in the illustration show how the corners are sometimes worked, bricks being cut or chamfered on the corner before being laid in position on the pier. This method is sometimes used when the piers are built in red bricks or stocks and there is a likelihood of the corners being damaged or chipped through rough wear.

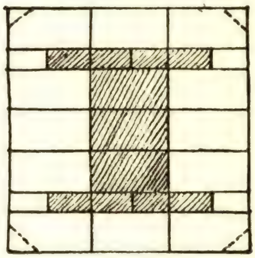


FIG. 201.

Fig. 202 shows the plan of the second course of a three-brick square pier in English bond. The front face course consists of a corner header and closer at either end of the course and three headers in the centre portion of the course. The left hand side face course consists of three stretchers. The right hand side face course consists of the bricks being placed in the same position as the left hand side face course. The back face course consists of a corner header and closer at either end of the course and the three headers again in the centre portion of the course. The vertical cross joints in the front face course, of which there are six in number, run through the whole width of the pier from the front face to the back face. This also occurs in the vertical cross joints of the right hand side face which run through the whole width of the pier to the left hand side face, only being in the reverse direction to the joints which run from front to the back of the pier. The dotted lines shown in this illustration seen close to the external angles of the pier indicate bull-nosed bricks, which are sometimes used in conjunction with stock piers, and also with piers entirely composed of blue bricks. They are used in the construction of piers liable to be subjected to rough usage of traffic, etc. The shaded lines show the internal portions which require to be filled in and include eight ordinary closers and three whole bricks in the internal central position of the pier.

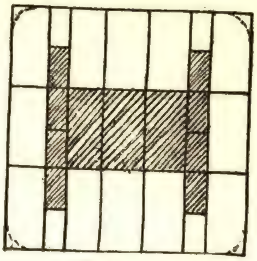


FIG. 202.

Next we will take the elevations of the piers in English bond. In the 9-inch pier, which contains two whole bricks in each course, the first course in the elevation would show two headers, these two headers being reversed, showing a stretcher in the second course at the front face course and also at the back face course.

Square Piers in Flemish Bond.—The first square pier we will take as an example will be Fig. 203, which shows the plan of the first and second courses of a one and a half brick square pier in Flemish bond. The first course is shown in plain lines, and the face course consists of a stretcher and header. The left hand side face course consists of stretcher and header. The back face course consists of stretcher and header, and the right hand side also consists of a header and a stretcher. The internal space required to be filled in with a bat or half brick is marked B. The second course is marked with dotted lines, the positions of the bricks being reversed. The bricks laid in this pier form a 4½-inch casing to the pier, the middle portion being filled in every course by the bat. This bond forms a very weak pier, and is only used in cheap construction or in piers built for ornament and not for strength. There is a vertical straight joint on all sides of this internal bat throughout the height of the pier.

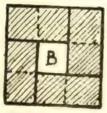


FIG. 203.

Fig. 204 shows the plan of the first course of a two-brick square pier in Flemish bond. The front face course consists of two corner headers with two queen closers next to them and a central header. The right hand side face course consists of two corner three-quarters and a header in the centre of them. In the left hand side face course the bricks are placed in the same position as those in the right hand side face course. The back face course

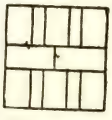


FIG. 204.

corresponds exactly to that of the front face course. The vertical cross joints of the central header, which are on each side of it, in the left and right hand side face courses of the pier, run the whole width of the pier.

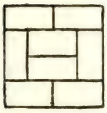


FIG. 205.

Fig. 205 shows the plan of the second course of a two-brick square in Flemish bond. This course consists entirely of whole bricks. The front face course consists of two stretchers; the left and right hand side face courses of two corner headers with a stretcher placed in position between them and the back face course of two stretchers. There is a 9 inches by 9 inches internal space to be filled in; two whole bricks are placed here to fill this internal space.

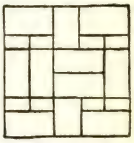


FIG. 206.

Fig. 206 shows the plan of the first course of a two and a half brick square pier in Flemish bond. The front face course consists of two corner stretchers and a central header. The left hand side face course consists of two corner headers with closers next to them, one at either end of the course, with a stretcher placed between them. The right hand side face course is exactly the same as the left hand side face course. The back face course consists of two stretchers on the corners and a central header between them. The two central headers, one in the front face course and the other in the back face course, recede into the wall three-quarters of the length of a brick. The internal portions which require filling in include four internal ordinary closers and three whole bricks.

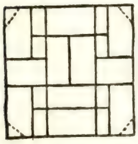
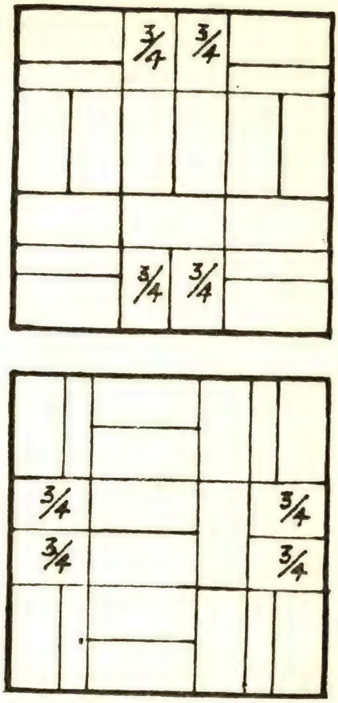


FIG. 207.

Fig. 207 shows the plan of the second course of a two and a half brick square pier in Flemish bond. The front face course consists of two corner headers, one at either end of the course, two closers, one next to each of the corner headers, and a stretcher in between them. The left hand side face course and the right hand side face course are the same and consist of two corner stretchers and a central header between them. The header which shows on the left and the right hand side face courses recedes into the wall three-quarters of the length of a brick. The back face course consists of two corner headers, two closers, and a central stretcher in between. The spaces in the internal part of the wall are filled in with four internal ordinary closers, and three whole bricks. The dotted lines shown near the external angles of the pier have already been explained in the piers showing English bond.

Fig. 208 shows the plan of the first course of a three-brick square pier in Flemish bond. The front face course consists of two corner stretchers and two headers placed centrally between them. The left hand side face course, from front to back, consists of corner header, queen closer, header, stretcher, queen closer, and the corner header. The right hand side face course is the same as the left hand side face course. The back face course is exactly the same as the front face course. The central face headers, two of which are central in the front face course, and two in the back face course, recede into the interior of the wall three-quarters of the length of a whole brick, and are marked $\frac{3}{4}$.

Fig. 209 shows the plan of the second course of a three-brick square pier in Flemish bond. The front face course consists of two corner headers, one at each end of the course. Next to them, at either end, are two queen closers. Next to the left hand closer on the front face is placed a stretcher, and then a header is placed between this and the right hand closer in the front face course. The left hand side face course and the right hand side face course are the same, starting from the front corner stretcher. Next to it are placed two headers and then another stretcher. The back face course is the same as the front face course. The four headers, two of which are on the left and two of which are on the right hand side face of the wall, recede into the interior of the wall three-quarters of the length of a whole brick. The bricks which require placing into the interior portion of the pier to form the correct bond consist of five whole bricks. The stretcher on the front face course and the stretcher on the back face course and the four internal whole bricks form a heading course, running through the whole width of the pier. We will now take examples of the elevations of the one and a half brick square pier, two-brick, two and a half, and three-brick square pier.



FIGS. 208 and 209.

Squint Piers.—Apart from these rectangular piers there are others of irregular shape, known as "squint piers." They are sometimes used at the external squint angles of bay windows, etc. Before we proceed to the various plans and elevations as shown it will be as well to explain the various bricks which are often used on the internal and external corners of these piers.

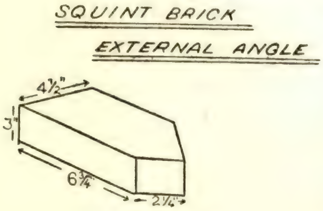


FIG. 210.

Fig. 210 shows the isometric view of the squint brick which is used at the external angle of a squint pier or wall. This measures $6\frac{3}{4}$ inches on the stretcher face and $2\frac{1}{4}$ inches on the return squint face of the brick. The back portion of this is also cut off square with the $2\frac{1}{4}$-inch squint face, so that this portion can be placed against the closer which usually comes next to it on the squint corner.

Fig. 211 is also an isometric view of the squint brick, the shaded parts showing the portions which have to be cut from the whole brick in order to obtain the required shape of the squint brick.

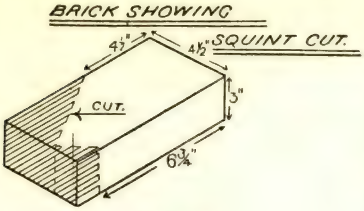


FIG. 211.

Fig. 212 shows the isometric view of the cant brick, which is invariably used in square piers, or at the external corners of walls. The shaded portion shows the part of the brick which is cut away in order to obtain the required shape.

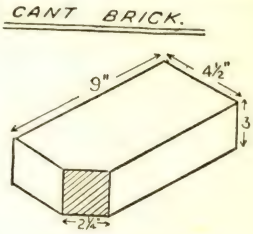


FIG. 212.

Fig. 213 shows the isometric view of a bird's-mouth header, which is used in the internal angle of an obtuse angle wall or pier. This brick is cut on the header end, and the angular shape is cut to suit the required internal angle of the wall or pier. These bird's-mouth headers are placed in the internal angle of the wall, every other course alternately throughout the height of the wall.

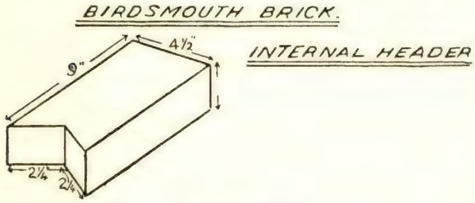


FIG. 213.

Fig. 214 shows the isometric view of a bird's-mouth brick. It is of purpose-made or specially made brick type, being moulded to the required internal angle. This is called the internal stretcher bird's-mouth brick. The stretcher face on the internal angle of the wall or pier measures 6¾ inches, and the small closer return in the internal angle of this brick measures 2¼ inches. The two end header parts of this brick, which are 4½ inches, form the vertical internal cross joints in the internal part of the wall, when the other bricks at either end are placed in position against them.

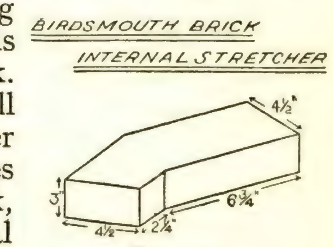


FIG. 214.

Fig. 215 shows the plan of a small squint pier which measures 6⅞ inches on the front face of the pier, and the same measurement on the return front face. The front face is formed with the header, and 2¼-inch portion of the squint corner brick. The return front face is formed with the stretcher face of the squint corner brick, the pier being 9 inches in thickness. The internal angle face consists of two headers, one being a shaped brick.

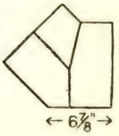


FIG. 215.

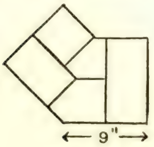


FIG. 216.

Fig. 216 is the plan of a little larger squint pier, which measures 9 inches on the front face, and the same measurement on the return front face. The pier is 9 inches in thickness. The front face course is composed of a header and a bat. This bat is formed into a squint and forms 2¼ inches of the front return face, next to this is another three-quarter. The back internal angle consists of a shaped bat, a header showing at either side of this.

Reveals.—Fig. 217 shows the plan of another squint pier, a bit larger on the face than the two previous ones. The front face course consists of a three-quarter brick and a large bat, which forms the corner squint and also forms a 2¼-inch face on the return face course of the pier. This front face course measures 11⅜ inches on the front face of the pier; next to the squint corner brick on the return front face is a header, and next to this is a bat. The three-quarter brick on the front face and the bat on the return front face form the two reveal bricks at either end of the squint pier. These reveals are 4½ inches back from the face of the pier. There is also a recess showing behind these reveal bricks 4½ inches from the ends.

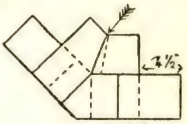


FIG. 217.

Jambs.—The internal 4½-inch faces are known as the jambs. The internal face course is composed of two headers. One is a shaped bat which fits into the internal angle and the other is the back face of the return front face header, which is next to the squint corner brick. The header is also shaped on the internal 4½-inch portion, and fits against the shaped bat in the internal angle; this forms the internal vertical cross joint.

Fig. 218 shows another plan of a squint pier, with reveals and jambs at either end; the length of the front face course is 1 foot 1½ inches, and consists of a three-quarter reveal brick and a squint brick, which shows three-quarters of the length of a brick on this face course, 2¼ inches of it showing on the return face course. Next to this on the return face course is placed the closer. Next to this a whole brick forming a header on the face, and a bat next to this, which forms the reveal brick. The back face consists of three-quarters of a brick, the internal portion of it being cut off. Next to this is a header which is the back face of the header in the return face course. The cut three-quarter placed against this header forms the internal angle vertical cross joint. This pier shows two 4½-inch reveals, one at each end, and two 4½-inch jambs, one at each end in the internal 4½-inch portion of the wall.

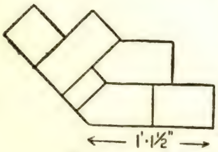


FIG. 218.

Fig. 219 shows the plan of a larger squint pier than the previous ones, this being one brick and a half in thickness, and showing two 4½-inch reveals, one at each end of the pier, and two 9-inch jambs, one at each end of the internal 9-inch portion of the pier. The front face consists of a three-quarter brick. Next to it is a header, which is shaped at the internal half of its length. Next to this is the squint corner brick, which shows three-quarters of the length of a brick on this face. The return face course shows the 2¼-inch

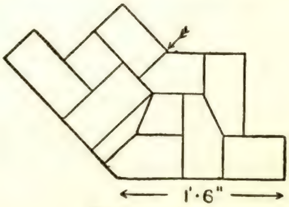


FIG. 219.

face of the squint corner brick. Next to this is placed the queen closer, which is splayed on its internal 4½-inch portion. Next to this is a header, and following this is a stretcher, which forms the reveal brick. The internal face course consists of a three-quarter brick. At the back of this is placed a bat in the internal 4½-inch centre portion of the wall; this forms the 9-inch face of the left hand jamb. The right hand jamb is shown by a stretcher. This also forms a header in the internal face course. Next to this, and placed in the internal angle, is a shaped brick, which shows as a header, or half brick, in the internal face at the angle. This brick is placed against the three-quarter in the internal face of the pier and forms the internal angle vertical cross joint as indicated by the arrow mark.

Fig. 220 shows the plan of a pier, which is 18 inches on the front face, and 14 inches in thickness. The front face course of the pier shows two stretchers. The back face of the pier shows two headers. There is a 4½-inch reveal at either end of the pier, showing a recess behind it of 4½ inches, and a 9-inch jamb at either end of the internal 9-inch portion of the wall. This shows the first course of this pier.

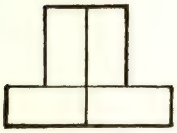


FIG. 220.

In the front elevation of this pier the first course shows two stretchers, the returns of which show as headers on the reveals at either end. The second course shows two three-quarters, which also form the reveal bricks and show as headers on the face of the reveal. A header is placed centrally between them in the same course.

Fig. 221 shows the plan of the second course of the pier. The front face course consists of two three-quarter bricks, which form the reveal bricks, and a centre header, placed between them. The back face of this pier consists of a stretcher. At the left hand side of the jamb an ordinary closer is placed behind the back face stretcher in the interior 4½-inch portion of the wall. This completes the face of the jamb, which shows two headers on its face. The same method is used at the right hand side jamb to complete the 9-inch face of it.

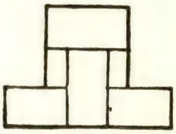


FIG. 221.

In the back elevation of this pier the elevation shows the back of the reveal bricks as well as the face of the back pier. The straight perpendicular lines which run the whole of the height of the elevation are the external sides of the 9-inch back pier. The left and right extreme perpendicular lines in the elevation are the ends of the reveal bricks. The first course in the elevation, from left to right, shows the back half brick face of the left reveal brick. Next to this is the stretcher as shown on the face of the pier, and the right hand back face half brick of the reveal. The second course in the elevation shows the same, except the face of the pier which consists of two headers as in Fig. 218.

Fig. 222 shows the plan and also the back elevation of a squint pier.

The front face course of the pier on plan consists of a header which shows as a stretcher on the right hand reveal face. Next to it is the squint, which also shows as a header on this face; on the return front face of the pier 2¼ inches of the squint is shown and next to it a three-quarter, which shows as a header on the left hand reveal face. The internal face course consists of a header and a shaped brick which forms the internal angle, and also forms the back header to the left hand side reveal face. The dotted lines on the plan, which show the position of the second course of bricks, are continued in a perpendicular direction to the back elevation, in which there are four courses, and also shows the position of the bricks at either side of the extreme internal angle. This internal angle is shown by the perpendicular line throughout the height of the four courses.

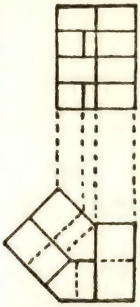


FIG. 222.

Fig. 223 shows the front elevation of the pier in Fig. 222. The first course consists of, reading from left to right, reveal brick, which shows three-quarters of the length of a brick on the face, next to this a 2¼-inch face of the squint brick is shown. The perpendicular line running the length of the elevation shows the external point of the squint brick. Next to this is the half brick face of the squint brick and following this is another header showing on face of pier, which returns as a stretcher on the right hand side face of the reveal. The second course starting from left to right, shown as dotted lines in the plan, starts with reveal brick, and shows a header on the face. Next is the three-quarter face of the squint brick. Then the extreme angle point of the pier on the return 2¼ inches is shown of the squint brick, and then follows a three-quarter brick which shows a header on the right hand face of the reveal.

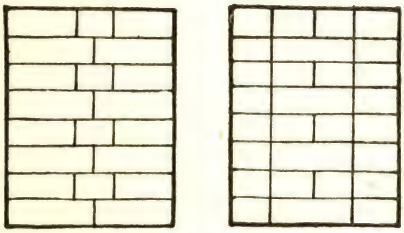


FIG. 223.

Fig. 224 shows the plan of two courses of a squint pier, and also the back elevation. The first course of the plan consists of, starting from left to right, bat or half brick, which forms the reveal, also showing as header on the reveal face; next to it a header; next ordinary closer, and next to this 2¼-inch face of the squint brick. Then follows on the return the three-quarter face of the squint brick and next to this a three-quarter, which forms the reveal brick, and shows as a header on the reveal face. The next course, which is shown with dotted lines, starts from the left with a three-quarter reveal brick, showing as a header on the reveal face. Next to this we have the three-quarter face of the squint brick, on the return the 2¼-inch face of the squint brick. Next follows

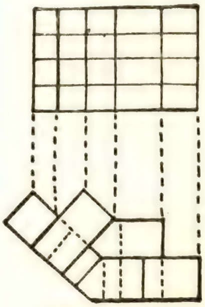


FIG. 224.

the ordinary closer and header and then again we have the half brick, which shows as a header on the face and also as a header on the right hand face of the reveal. The perpendicular dotted lines as shown extend to the first course of the back elevation. This shows the back elevation of the pier extending from the left reveal brick to the right reveal brick and shows the position of the jambs and also the recesses behind the front reveal bricks.

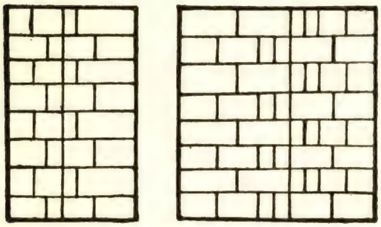


FIG. 225.

Fig. 225 shows the front elevation of the pier in Fig. 224. The first course consists, from left to right, header, header, closer, squint brick. The perpendicular line throughout the height of the elevation, which shows the extreme point of the squint brick, is between the $2\frac{1}{4}$-inch face of the squint brick, and the $\frac{3}{4}$-inch face of the squint brick. Next to this is the three-quarter brick, which forms the right hand reveal. The second course consists of, starting from left to right, a three-quarter brick, and next to it the three-quarter face of the squint corner brick. The perpendicular line is the extreme angle point of the squint brick, next show the return $2\frac{1}{4}$-inch face of the squint brick, ordinary closer next, then a header, then another header, which is a bat or half brick, and which forms the right hand side reveal brick.

CHAPTER XI

JOINTING AND POINTING

Jointing—Struck Joint—Pointing—Types of Jointing and Pointing—Flat Jointing—Tuck Joint—Colouring—Masons' V Joint—Weathered Joint—Flat Joint Pointed—Bastard Tuck Pointing—Gauged Joint—Recessed Joint—Beaded Joint– Keyed Joints—Flush Joints—Other Types of Joints—Coloured Pointing—Finishing Off—Yellow Stopping, etc.

BRICKWORK depends for its stability on the quality of the jointing, that is to say, the use of mortar for the purpose of cementing, or jointing, the bricks together.

The importance of knitting into a compact mass is well brought out in an official publication of the American Society for Testing Materials. " There appears to be a widespread belief that the percentage of absorption of individual bricks is a governing factor in the ability of brick masonry to resist moisture penetration. It has been conclusively shown that this belief is erroneous. On the contrary, a certain amount of absorption in the brick assists in obtaining a better bond between brick and mortar and therefore a more watertight joint. Any water penetration in brick masonry undoubtedly passes largely through the mortar joint and not through the brick." This has been fairly widely admitted and as a result waterproofing compounds are now commonly added to the mortars in first-class work. For this purpose 2 per cent. of ammonium stearate, or one of the patent materials, is added to the lime or cement before gauging.

We have already seen the importance of preparing good mortar with sound materials, and we must now consider its proper application.

There are various joints in brickwork, the principal of which are: the struck joint, flat joint, flush joint, weather or weathered joint, flat joint pointed, recessed joint, keyed joint, tuck joint, bastard tuck joint, beaded joint, masons' V joint, and gauged joint. These joints fall into two classes: jointing and pointing.

Jointing.—The term " jointing " is applied to the original bedding and cementing of the bricks with mortar. These operations comprise the spreading of the bed of mortar in which the bricks are pressed down, the plastering of the ends of the bricks, and the shaping of the excess mortar both on the internal and external faces. There is no addition of other mortar.

When the original bed of mortar has been spread and the bricks pressed down into it, the mortar is more or less of a spongy or porous character, partly owing to the extraction of moisture from it by absorption by the bricks (which, therefore, should be well wetted to lessen absorption) and partly by evaporation. The result is that small air cells are formed which prevent perfect adhesion. This dehydration is unequal, being more pronounced towards the faces, where evaporation as well as absorption has to be reckoned with, the inner portions of the joints being protected from the latter influence. To remedy this the outer portion of the joint has to be solidified by being compressed, which expels the air bubbles and consolidates the mortar into a compact mass. The joint is then ironed, or smoothed, which seals it, lessening subsequent absorption of moisture from the air or rain. The ironing or smoothing of the joint is carried out by the bricklayer either with a pointing trowel or the brick trowel. For this operation the blade of the trowel is placed almost flat against the wall and pressure applied, the stroke being in one direction only . This action tends to close all the small holes or pores on the surface of the joint. The backward and forward strokes should not be used, because the reversing of the stroke would disturb the mortar, setting up new cavities or air cells. A little thought will show that while the one stroke tends to close the small pores of the joint, the reverse stroke opens them.

Fig. 226 gives a view of a good example of a struck joint. This joint is bevelled by compressing the lower edge of the joint by holding the blade of the trowel almost flat against the joint, and pressing the lowest face edge of the trowel more against the bottom of the joint than the top; at the same time working the trowel in a backward direction. This joint should never be applied on external face work, owing to the formation of the joint which leaves the top edge of the brick exposed in each course. In exposed positions moisture and rain would penetrate at this point and find its way into the internal part of the joint. This joint is used extensively for inside work, where the walls are dry and where walls are whitewashed.

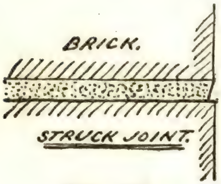


FIG. 226.

Pointing.—Pointing is the method used in the treatment of a joint where the external portion of the original joint is removed to the depth of ½ inch in new work, and ¾ inch in old work, and substituting a better mortar, according to the style of finish desired.

Types of Jointing and Pointing.—We will now explain the different types of jointing and pointing, and how the work is carried out.

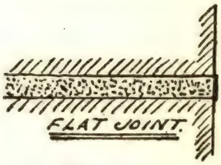


FIG. 227.

Flat Jointing.—Fig. 227 is an illustration of the flat joint. The joint should be constructed for inside work only, as it has the same tendency to absorb water as the struck joint, but at a different point, in this case it is at the top of the joint. In each case dampness is likely to penetrate into the wall. This joint is formed by making a full flat joint, by pressing the material with the trowel held flat against the wall. The pressure of the material by the trowel in forming the face surface of the joints causes a slight surplus of material to extend beyond the bottom and top line of the joint. This surplus is neatly cut off by the bricklayer with a knife-shaped tool, termed a frenchman.

Tuck Joint.—Fig. 228.—This is an illustration of the tuck joint. This comes under the class of pointing, which class of joint is used in pointing old and new brickwork. In new brickwork of the villa type it is often used to cover up the roughness of the brickwork, such as rough edges of the brick, and very often I have noticed it has been used to cover up discrepancies in the bond of the brickwork. More legitimately this style of pointing is used extensively in renovating and brightening up old brickwork. In fact this class of pointing is executed more for show than for durability. It should not be executed on walls or houses that are in exposed positions. I have known cases which after a year or two looked in a deplorable condition owing to bad weathering. The white joints had been washed off by beating rains, and various coloured patches appeared owing to dampness and other causes. There is a considerable quantity of this pointing done internally; this naturally lasts much longer than outside work. In adopting this class of pointing for old brickwork, the joints should be first thoroughly raked out to a depth of ¾ inch. The whole brickwork and joints should then be well brushed, and thoroughly wetted before applying the mortar.

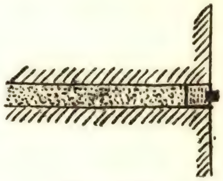


FIG. 228.

Colouring.—If colouring is to be applied to the bricks, the whole of the front should be given a colour wash at one time. This gives a uniform colour to the whole of the work which has to be pointed. Another method is to give the front a colour wash after the stopping material has been placed in the joints. The best effect is procured when two coats are employed, viz. one before the stopping is placed in the joints and one after the stopping is in the joints. Old brickwork generally requires two coats of wash before a good colour is obtained. A third method often adopted is to give the front a coat of wash before the stopping is placed in the joints, and then mixing some of the wash in the material which is used for stopping. When the stopping is placed in the joints, it should be rubbed with a cloth or piece of sacking over the whole surface of the joints and bricks. By this method a uniform colour of the whole surface is obtained. Sometimes the latter method is used without the first wash. This should be done only when the bricks are of a good colour and not too dirty. After the colouring of the work the position of the bed joints, and cross joints, are determined, the bed joints being usually measured and struck with a chalk line; the first cross joints or division lines are generally defined by hanging a lead bowl in position. This ensures their being in a perpendicular position. The rest are measured; if good work existed, new joints would come in exactly the same position as the old ones. The next operation is to fill or stop in the joints which have been racked out.

A good lime mortar should be used for this purpose and the material should be well pressed into the joints to form adhesion to the old mortar which forms the original joints. After this material has been placed in the joints, the face of the work should be rubbed over with rags to form a uniform colour in the joints and bricks. I might mention here that only one section should be done at a time. This enables the white joint to be placed on the stopping before the latter is set, while ensuring that the white joint adheres better to the stopping when pressed into it. After the stopping has been rubbed down, a straight edge should be held in a horizontal position along the bed joints and an indent made in the stopping to receive the white putty joint. This is done by drawing a jointer along in a horizontal direction on the top edge of the straight edge. This indent should be roughed to form a key for the putty point. The cross joints should be made in the same way. The white joint should then be pressed in the indent which was formed by the jointer in the stopping. This white joint is put on by the jointer, which the bricklayer uses. A straight edge is used in conjunction with this. The bricklayer generally places a small pat of the lime putty and silver sand on the face of the straight edge; he then places the straight edge against the bed joint on the wall in a horizontal position, takes the jointer in the hand which is free and with the bottom edge of the jointer he pushes the material on to it in a sideward direction, from the small pat which is on the straight edge. Sufficient material adheres to the jointer to form part of a bed joint. With the material on the jointer he presses it into the indent which is formed in the stopping material. By running the jointer along the top of the straight edge he is able to keep a straight horizontal position in forming his joint. When pressing the white joint into the stopping a certain amount of surplus material is formed on either side of the edge of the jointer. This is neatly cut off top and bottom horizontally with the aid of the frenchman, and forms a neat, white parallel joint. The cross joints are treated in the same way.

When these white joints are being cut, there is a surplus of material which falls from them. This should be allowed to fall between the wall and the straight edge, so as to keep the face of the wall as clean as possible. Small strips are generally placed at the back of the straight edge to enable this to take place. The straight edge is also bevelled at the top edge.

Various washes are used in different colours. A wash that is required to represent the appearance of new stock work, or a yellow or straw tint, is generally made up of a composition containing green copperas and yellow ochre, added in proportions to suit the required tint to be used. When a wash for red brickwork is required or an old stock front to be coloured red, to represent red brickwork, a composition of the various materials are used: 14 lb. of dry red ochre, a small percentage of alum, ½ lb. of salt, and 5 lb. of slaked lime; these materials should be placed in hot water and dissolved. The wash should be applied to the work in the hot state. This quantity would be sufficient to wash down the ordinary suburban house front. A wash suitable for an old white Suffolk front would be white copperas and a portion of lime. This, as in the other cases, should be dissolved in hot water and applied in a hot state. Salt in a small proportion can also be used in conjunction with the latter. For a black wash, green copperas again is used as a base, in conjunction with ivory black or lamp black. A wash which is sometimes used to brighten up old brickwork consists of glue dissolved in water, with the addition of a portion of bicarbonate of potash, a small portion of venetian red, and enough yellow ochre to get the desired tint. All the materials should be dissolved in hot water, applied immediately with a brush, and at the same time the wash should be kept well stirred. The latter applies to an old red front. Another mixture used for brightening up old stock work, and cleaning it, consists of 1 pint of liquid ammonia, 1 gallon of soft soap, 2 lb. of powdered pumice stone; make into a soft paste, and give the bricks a good coating, allow it to dry and stand for 30 minutes, then scrub off with brush and clean water and afterwards finish off with the hose.

Readers should refer to the *Pointing of Brickwork* for further details.

The material for the stopping consists of a good lime mortar: 1 part of good hydraulic lime to three parts of good sharp sand. This should be made and thoroughly slaked, as mentioned in the chapter on Materials. It should then be sifted through a fine sieve, and covered over, using it as required. The white joint consists of lime putty, which should be run into a tank and used as required with silver sand to form a stiff paste. Clean water should be used in all mixings of the various materials which are required.

Masons' V Joint (Fig. 229) is an illustration of the masons' V joint, sometimes used in the laying of artificial stone blocks, a class of work which is done at various times by the bricklayer. This joint comes under the category of jointing, the same material forming the external shaped joint as the internal material of the joint. This joint is made after the same method as the tuck joint, only a different shaped jointer is used for the purpose.

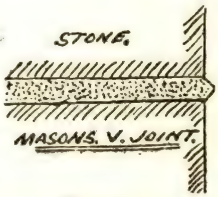


FIG. 229.

Weathered Joints.—Fig. 230 is an illustration of a joint which is generally used in London and the provinces and other parts of the kingdom for external brickwork. This is known as the weather joint. This joint is shaped on the external face by the bricklayer compressing the top portion of the joint more than the bottom, holding the blade of the trowel at an angle of 45 degrees, and well ironing the joint with a one-direction stroke. The slope of the joint in an outward direction from top to bottom throws the water, which accumulates on the face, away from the face of the wall. The lower edge of the joint should be made so as to come slightly in front of the face of the wall. This prevents the water from percolating into the bottom edge of the joint and top portion of the brick in the lower course, which very often occurs if the lower portion of the joint is made exactly with the line of the face of the wall. The point here mentioned is shown on the diagram with a very slight projection. When a number of joints have been made, they should be cut off neatly at the top and bottom edge, exactly parallel with each other. This is again performed by the use of the frenchman in conjunction with the pointing straight edge. Walls pointed in this manner are usually external walls, old and new. In order to obtain a good key to the existing material, the existing joints should be raked or cut back from the face of the wall ¾ inch, well wetted, and the material used for the weather joint well pressed into the external part of joint which has been raked out. Of course, in all kinds of pointing the old existing joints should be well wetted. This kind of joint also comes under both classes of pointing and jointing, the latter when the joints are shaped externally with the same material which forms the whole joint. This is sometimes done on external work where the joints are made and finished as the work proceeds. This method is adopted at times where there is only one internal scaffold in use; there being no external scaffold to work on, the bricklayer has to use the overhand method of working. In this method the bricklayer laying in the external course of the wall is obliged to reach with his hands across or over the wall. After the external course is laid he finishes the external joints course by course as the work proceeds; hence the term "overhand work."

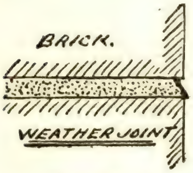


FIG. 230.

Walls are also pointed with this kind of joint as the work proceeds, when there is an external scaffold existing.

Jointing is undoubtedly the strongest form of construction, because the joint is made and finished with one kind of material, thus forming a complete union extending the whole width of the wall. With pointing in which two distinct batches of mortar are used, there is great danger, if not properly constructed, because it is a compound joint, and there is a tendency for the two sections to part. This is especially the case if the old joints are cut or raked out only for a small depth from the face of the wall, and the mortar merely skimmed over them. So-called pointing of this class will not last very long. The rain or frost soon penetrates the joints, getting behind the thin surface of mortar and forcing it out. Therefore, whenever possible, the two mortars should be as closely alike as possible unless the original jointing has a good key and the pointing is of a strong adhesive description, like putty or a good cement mortar.

Mortar which is used for the construction of the weather joint on external brickwork should be of good material. The component parts for a good mixing would be, one part of Portland cement and two parts of good pit sand, mixed with clean water to the consistence of a good stiff paste.

Flat Joint Pointed.—Fig. 231 is an illustration of the flat joint pointed. This class of joint comes under the category of jointing. As will be seen, the whole joint is composed of the same material. It is used for internal work. The joints in this case are made flat on the external face of the wall by the bricklayer pressing the joint with the blade of the trowel, just after each brick is laid. Two or three courses are laid and the joints treated by the same method. The joints are then rubbed over lightly with a piece of cloth, and then the indent is formed on the face of them by running the jointer along each joint and pressing firmly into the joint, the straight horizontal lines being obtained by the use of the pointing rule, which is used in conjunction with the jointer. The material for this class of joint generally consists of a good lime mortar.

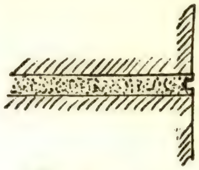


FIG. 231.

Bastard Tuck Pointing.—Fig. 232 is an illustration of the bastard tuck pointing. This joint consists of two materials, the original joint and the stopping mortar. The stopping mortar used for this class of joint is placed into the original joint by the same method as used in tuck pointing, the difference being the absence of the white putty joint. The jointer used for the shaping of the external joint is indented on its bed surface, or the bottom side of the blade. This is pressed against the joints, and a projection is formed on the face of the joint, the same shape as that existing on the bed of the jointer. This class of joint is used internally and sometimes externally on the face of walls. But it is not advisable to use this joint in an exposed position owing to the rain, which is liable to penetrate, or settle on the top ledges of the projections of the joints. The material for the formation of this class of pointing generally consists of a good lime mortar for the stopping for internal work, but a gauged mortar should be used for external work, viz. a good lime mortar with a small proportion of Portland cement.

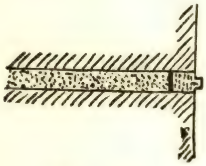


FIG. 232.

Gauged Joint.—Fig. 233 is an illustration of the gauged work joint. This joint is made by dipping specially prepared rubbed bricks in small box or tank containing lime putty. The bricks should be dipped very carefully and held level horizontally. The immersion of the brick into the putty should be just sufficient to give the brick a solid thin coat upon the bed surface. All bricks should be watered before they are dipped into the putty tank, as this gives the lime putty a better adherence to the surface of the brick. If in a dry state, even if thoroughly brushed, there would remain small particles of dust upon the surface of the brick, which would prevent the proper adhesion between the two substances. Great

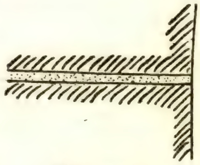


FIG. 233.

care should be taken to see that the joints are solid, especially towards the external face of the brick. If not solid, the joint will show pinholes and voids on the external surface, when the face is cleaned off. The thickness of these joints is usually about $\frac{1}{16}$ inch. Sometimes the joints are composed of white lead in powdered form and shellac. This material or mortar is only used by experienced cutters. Lime putty is the material generally used for the joints.

Recessed Joints.—Fig. 234 is an illustration of a recessed joint, which comes under the class of pointing, the joint being formed of two materials. It is slightly different from the flat joint which is jointed with a jointer, the difference being that this joint is shaped with a larger jointer, which extends the whole thickness of the joint. Recessed joints have a good appearance on an external wall built of pressed bricks, which have sharp keen arrises or edges.

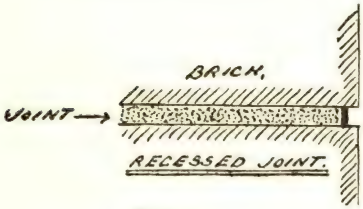


Fig. 234.

The existing joint is raked out for a depth of ½ inch from the external face of the wall, well wetted, and about ⅛ inch of material pressed against the original joint with a jointer the same size as the joint, the face of which is ⅛ inch back from the face of the wall. I have used white Atlas cement for this kind of joint with good effect, but if this joint is constructed in conjunction with bricks which have rough edges, it looks very unsightly.

Beaded Joints.—Fig. 235 is an illustration of the beaded joint. This joint is sometimes formed in one material, and sometimes with two. It is formed by the same method as employed in forming the bastard tuck joint. The difference arises from the indenting of the bottom of the jointer blade. In this case it is round; in the case of the former it is of a square shape. It is a joint used both for internal and external work, though any joints which show a projection in the finished form ought not to be used for external work.

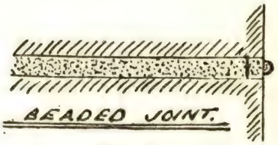


Fig. 235.

Keyed Joints.—Fig. 236 is an illustration of the keyed joint, which comes under the class of jointing, being formed with one material throughout the whole width of the wall. This is a form of the recessed joint. For this work the jointer should be of the same thickness as the original joint itself. It is formed by drawing the jointer along the joints of the brickwork, the shape of the jointer being a half round, or the bottom edge of the jointer blade. It is used on external work and is formed with either lime mortar or cement and sand. Cement and sand should be used by preference on external work. The bottom half of this joint tends to throw the water outwards from the wall.

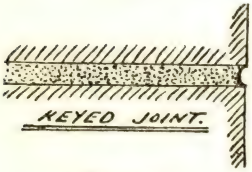


Fig. 236.

Flush Joints.—Fig. 237 is an illustration of the flush joint. This joint is composed of one material throughout the width of the wall. The joints are formed after the bricks are bedded by the bricklayer drawing the blade of the trowel along the face of the joints, holding it at right angles to the face of the wall. In doing this, he collects the surplus material which has been squeezed out of the joints whilst bedding the bricks, and at the same time the blade being held at right angles to the joint, gives a semi-rough surface to it. In these joints the intention is to show the rough particles of the material on the external face of the joint, which gives it an old, or rustic, appearance. Two-inch red sand faced bricks, with this method of jointing, produce a fine artistic effect. It is very useful when Old English brickwork has to be repaired or imitated.

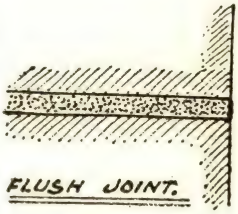


FIG. 237.

These joints are on the average, when formed in conjunction with these bricks, $\frac{5}{8}$ inch thick. Cement mortar, or gauged cement mortar, is generally used for this class of joint when used externally. A good lime mortar can be used for internal work, such as for panels, fireplaces, etc. This joint is sometimes finished off externally by a small piece of wood being drawn along the joint to produce that touch of roughness which is required for this class of work. Work of this type, with flush joints, is sometimes made with unwashed sand and Portland cement, the external part of the joint being left rough. This is done on the theory that in the course of a few years the small particles of dirt in the sand will work forward towards the external face of the joint, on account of the lack of adhesive power to combine with the other material in the joint, the roughness being increased naturally, so giving the appearance of age.

Other Types of Joints.—Fig. 238 shows a joint raked out to a depth of $\frac{3}{4}$ inch to form a key for the various kinds of mortars which are to be placed in it to form different types of pointing.

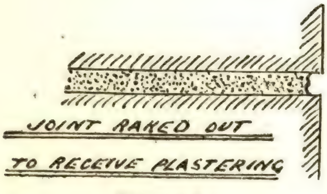


FIG. 238.

Often the joints which exist in old brickwork are of a very soft nature, and can be raked out with ease with the use of a shaped piece of iron called a " dog." In other cases the joints are very hard, and the hammer and bolster have to be used to cut them out. Great care should be taken not to damage the edges of the bricks. The joints as before mentioned, viz. the tuck joint and the bastard tuck joint, are used in many cases to cover up such defects as these. Joints are also raked out in this manner to form a key for walls which receive a cement or plaster rendering.

Fig. 239 shows a joint with the edges of the bricks in a rough, ragged state, the rough edges of bricks indicated by arrows showing how the stopping is used in tuck pointing to cover these defects.

Another kind of joint is used in conjunction with arches which are rough axed, that is, arch bricks which have to be cut to a template by the use of the hammer and bolster and then axed by the scutch, and finally rubbed slightly on the rubbing stone to form keen edges to the arch brick to complete the finishing shape. The joints used in bedding these bricks are usually about ⅛ inch in thickness, and finished and shaped externally with the one kind of mortar. The joint is generally of an angle shape, and finished off smoothly with the pointing trowel, the bricklayer pressing slightly more on one side than the other in a vertical direction usually adopted for arches.

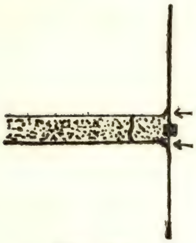


FIG. 239.

Fig. 240 shows this joint and the shape of the external finish. The material generally used for rough axe work is lime putty with the addition of Portland cement, liquid grout cement being used for joggling the bricks in the arch.

Coloured Pointing.—Various colours are used as washes for the brickwork in which the pointing consists of a tuck joint. The white putty joint is very effective with either the red, yellow, or black wash as a background. A red putty joint is sometimes used as a joint to a yellow wash as a background. The red wash as a background looks very well with a black putty joint. Old stock brickwork is sometimes washed with yellow, and the ordinary weather joint used, which may be formed of cement and sand, plain or with a little colouring matter to produce a black joint. An old white Suffolk front is sometimes washed with a white colouring for the background and a black putty joint used. A white background is also used in conjunction with a red putty joint.

Dinging.—Another form of pointing old and dilapidated brickwork is known as dinging. In this the old work and joints are brushed out and well wetted. Cement and fine sand are then placed in the joints of the bricks, also in all cracks and holes on the face of the bricks. The whole is then rubbed over with a brush, or a piece of sacking, to make a smooth face to the wall. The wall is next lined out to represent courses of bricks, with a small jointer, or a piece of stiff round wire about ⅛ inch in diameter.

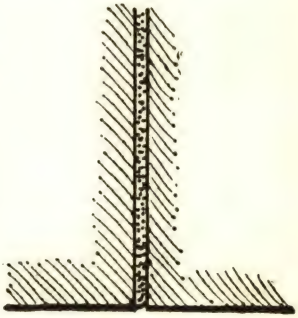


FIG. 240.

Gauged boxes should be used to measure out materials in such cases, especially if the mortar is to be coloured. This prevents the work when finished being of different shades. Nothing looks worse than to see a pointed front with different shades of pointing material in the joints on various scaffold heights.

Finishing Off.—When pointing on a scaffold a guard board should be placed against the wall in a horizontal position, especially in wet weather, to stop the splash of material from the scaffold towards the wall. All surplus mortar falling on the scaffold boards tends to make a mess, especially in rainy weather, so should be swept clean at intervals. If left overnight and the rain comes on, it splashes on the boards and also against the wall, staining it, so that when the scaffold is taken down a nasty ridge of mortar is left against the wall. It is often very difficult to remove it, especially if the material has set. Boards for holding the pointing material should be about 18 inches square. When pointing fronts of houses, shops, or offices, care should be taken to protect all inlets of gutters, rain-water pipes, etc. If unprotected, the materials which are used for pointing the walls sometimes fall into them, accumulates and sets, blocking the gutters and pipes and causing unnecessary expense in unstopping and renewing them.

When taking down or striking a scaffold care should be taken to fill in the putlog holes. It is too often noticeable that in a freshly putlog pointed building, the position of the holes recently filled in stand out more distinctly than the rest of the pointing. This is due to the larger beds and cross joints which contain a larger proportion of freshly made mortar than the bed joints and the cross joints of the rest of the pointing. The joints of the putlog holes should therefore be toned down so that the finished joint should match the rest of the pointing. This can be done by placing the half brick in the putlog hole, and filling half of the depth of the joint with brown paper, which should be well rammed in to form a solid mass and to hold the half brick in position. The rest of the joint should be filled with mortar and pointed on the external face to tone with the other pointing. I have seen this method used and have found the pointing in the positions of the putlog holes to tone with the other pointing in a short period.

STOPPINGS AND COLOURINGS REQUIRED WHEN REPOINTING AND COLOURING DOWN OLD FRONTS

Yellow Stopping.—One bushel of grey lime thoroughly slaked, mixed with 3 bushels of sand, the two ingredients to be blended dry and sifted; these can be mixed together with clean water, and about 28 lb. of yellow ochre added to colour, more or less quantity to suit shade of yellow required.

Black Stopping.—One bushel of grey lime thoroughly slaked, mixed with 3 bushels of foundry sand, the two ingredients to be thoroughly mixed dry and sifted, then mixed together with clean water, and if not dark enough shade, a small proportion of lamp black or vegetable black can be added.

Red Stopping.—One bushel of grey lime thoroughly slaked and mixed with 3 bushels of fine sand, the two should be thoroughly mixed dry and sifted, then mixed together with clean water, adding about 28 lb. of Venetian red or a little less or more if required to procure the desired shade of red.

Yellow Colouring.—Dissolve 2 lb. of green copperas in 4 gallons of hot water (clean), sometimes a little yellow ochre is used to procure the yellow shade; the mixture should be well stirred all the time it is being used for the wash.

Red Colouring.—Two pounds of Venetian red, 2 lb. of Spanish brown, and 2 lb. of white copperas. The whole of these ingredients to be dissolved and thoroughly mixed in hot water. Thoroughly stir when using the wash. Stale beer is sometimes added; when this is done, the quantity of copperas should be less.

Black Colouring.—Vegetable black thoroughly mixed in clean water (sometimes allum is added). This should be thoroughly dissolved in hot water before being mixed with the vegetable black. The whole should be kept well stirred when using.

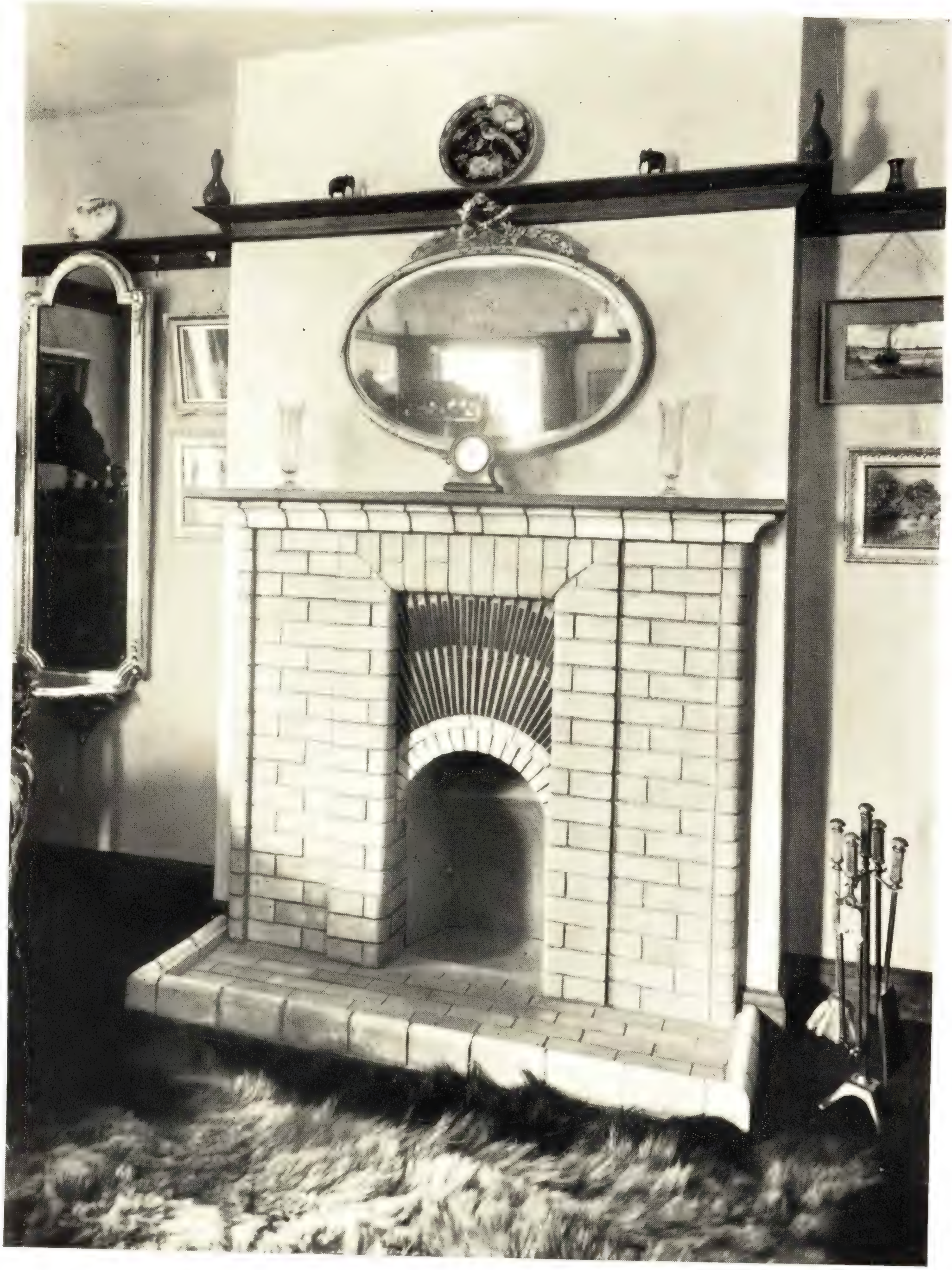
White Putty.—Quarter bushel of chalk lime and ½ peck of silver sand. Mix these thoroughly together with clean water to a stiff paste. Grey lime is sometimes used for white putty joints.

Black Putty.—Half bushel of grey lime, 1½ bushels of fine washed sand, and 14 lb. of vegetable black. All the ingredients should be sifted and mixed dry, then the whole should be thoroughly mixed together with clean water.

Red Putty.—Half bushel of grey lime, 1½ bushels of fine washed sand (the lime and sand should be mixed as in black putty), then add 14 lb. of Venetian red, and small quantity of Spanish brown to suit the required shade of red.

Tuck pointing requires ⅛ cubic foot of mortar per square yard.

Flat pointing or weather pointing requires ⅕ cubic foot of mortar per square yard. Pointing is measured by the square, which equals 10 feet by 10 feet or 100 superficial feet.



GLAZED BRICK AND TILE FIREPLACE.
Bricks by Lamb & Sons.

CHAPTER XII

FIREPLACES AND CHIMNEYS

Fireplaces—Hearths—Fender Walls—Sleeper Walls—Jambs—Chimney Bar—Flues—Size and Formation of Flues—Pargetting—Soot Doors—Chimney Stacks—Coring—Bonds in Chimney Stacks—Smoky Chimneys—By-laws—Furnace Stacks.

FIREPLACES and chimneys are specially important because not only do they concern the comfort and convenience of those dwelling in or using the buildings, but the safety of those buildings depend upon their proper construction. Hence, in this country, the design and construction of fireplaces and flues are controlled by by-laws (laws administered by local authorities). While these by-laws vary from district to district, to suit local conditions and requirements, they are all based on the Model Building By-laws drawn up by the former Local Government Board, and now administered by the Ministry of Health which replaced the old Board. These by-laws, founded on building science and the experience of the fire officer, prescribe certain regulations, much in the form of clauses in a specification, relating to the construction of the hearth, thickness of walls which enclose the fireplace, including the external or party wall at the back of the fireplace, and also the sides of the openings called the jambs; thickness of the breast walling, size of flues; thickness of division walls between flues, called withes; thickness of external walls to flues, known as chimney stacks; and also the materials of which the fireplace is constructed. The by-laws relating to the various parts of the fireplace and chimneys will be found at the end of this chapter.

We will now take the various parts which constitute the fireplace and flue.

Fireplace.—The fireplace is a recess formed in a room for the purpose of receiving a stove or grate, and when finished it is used for warming the room and conveying the smoke through the flue to the external air.

Hearths.—The bottom portion of the fireplace consists of the hearth. This is generally constructed with tiles, hard bricks, York stone, or concrete. The size of the hearth should be 18 inches in width from the face of the jambs extending into the room, and the length should be 12 inches longer than the length of the opening, that is, 6 inches at either side of the jambs. This part of the hearth is called the *front hearth.* The *back hearth* is that portion which is in the recess of the opening; the width being from the back wall of the recess to the front face of the jambs, the length being the distance between the two jambs (see Figs. 241 and 242).

The object of the hearth is to prevent fire spreading, which is sometimes caused by hot fuel from the stove or grate. The hearth, being made of an incombustible material, should prevent this, and the carrying forward of this material in front of the jambs should also ensure this object. Another cause of fire is that burning fuel after falling has a tendency to roll forward and come in contact with the floorboards. This cause of fire can be guarded against by constructing a reinforced concrete tiled finish fender or curb, if the hearth is constructed on the ground floor. The usual method is to fill in the internal space between the external wall and the fender walls with hardcore, well rammed, and finish with 6 inches of cement concrete, allowing a margin for finishing the surface with either cement and sand, York stone, or tiles. The finished level of the hearth is usually the same level as the surrounding floor, though in some cases a false hearth is raised several inches above the true hearth; for instance, in the old farm-house type and the modern well fireplaces. Hardcore for filling in under the hearth is to be preferred instead of earth, as it eliminates all traces of dampness.

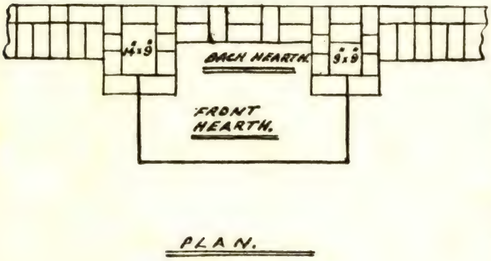


FIG. 241.

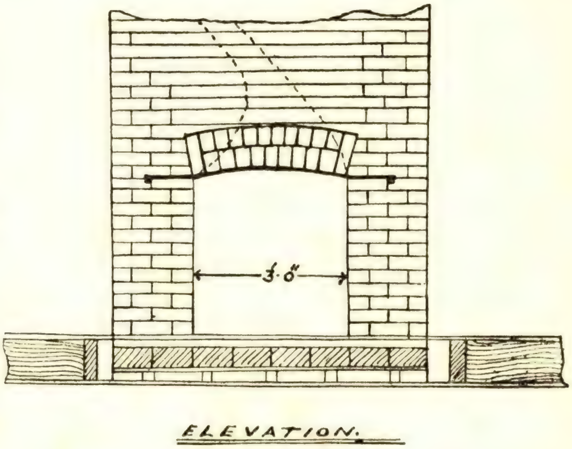
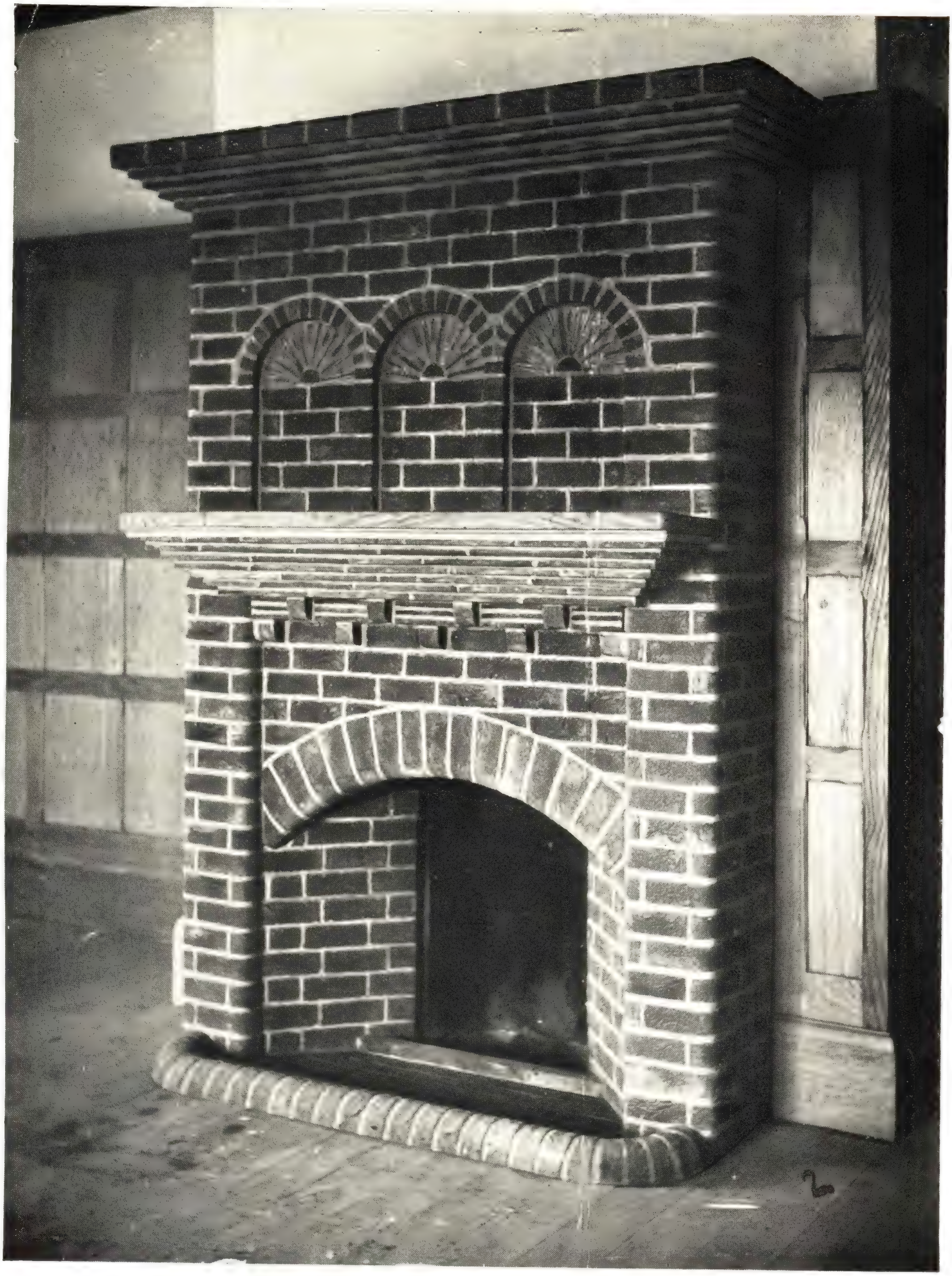


FIG. 242.

Frequently ground floor hearths are finished with a 3-inch York stone, forming the surface of the hearth. Underneath the stone between the fender wall and the external wall is filled in with concrete. The fender wall supports the stone which is used to form the hearth and also forms a support for the floor plate and floor joists.

Hearths which are required for upper floors are formed in a different manner. Fig. 243 is an illustration of a section through the hearth which is constructed on an upper floor. The incombustible material which is necessary for the support of the hearth is in this case a brick arch, which springs from the internal face of the external wall. This wall forms the springing on one side; the support for the springing of the arch on the other side is in the form of a wedge-shaped block, securely



BRICK CHIMNEYPIECE AND KERB IN "TUDOR" STYLE.
Bricks by Lamb & Sons.

fixed against the side of the trimmer joist. This diagram shows a section of the arch through the centre. It is composed of whole bricks laid half bond in its longitudinal section, which takes the support of the concrete and hearth in its whole length. On the concrete is laid and bedded a 3-inch York stone which forms the finished surface of the hearth. This finishes, as will be seen, at the same level as the surrounding floor boards. A wooden fillet or frame is generally fixed round the external line of the hearth. Under this section is another detail of the method of construction used in supporting the hearth with an arch. In this case a square fillet is used which is securely fixed against the trimmer joists for supporting the trimmer arch, the arch butting against the trimmer joists. The same method for filling in the concrete over the arch can be used as described above. The finished hearth can either be composed of a tile or cement finish according to taste. Fig. 243 also shows two methods of butting the trimmer arch against the trimmer joists, in one case a wedge being fixed against the trimmer joist, and in the other a square fillet supports the trimmer arch.

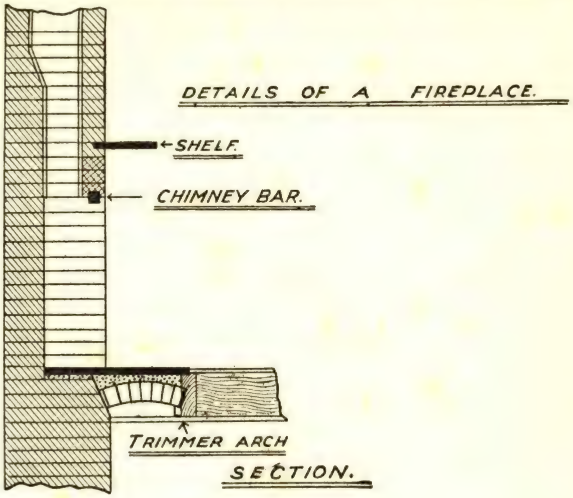


FIG. 243.

Fig. 244 is another method showing the trimmer arch butting against the trimmer joist. In this case it is supported by a wooden centre. This can be left in after construction, when the bottom of it would form a fixing for the laths for the ceiling below. The trimmer arch has only one skewback, which is against the internal face of the external wall. The finished hearth in this section is composed of 1½ inches of cement and sand.

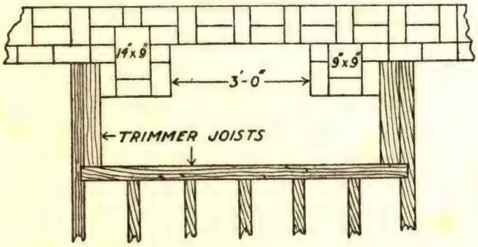


FIG. 244.

In a different method of construction for a first-floor hearth, the hearth is formed by fixing the T irons in the main wall for a depth of 9 inches. These must be properly bedded, wedged, and fixed securely in cement and sand. The irons must be bedded in the wall with the flat part of the flange facing downwards. The other ends of the irons butt against the trimmer joist. At each end of the hearth an angle iron is fixed into the wall for the same depth, and rests against the sides of the trimmer joist, which is at each end of the hearth. When these irons have been securely fixed and the material is set, shuttering is fixed beneath them. Tiles are then fixed between the irons. This forms a key for the ceiling rendering material below. These tiles keep the irons in the correct positions. Concrete is then placed between the irons and brought up to a level with the under side of the finished material which is required for the external face of the hearth. This method of construction for a first-floor hearth is very good, providing materials and workmanship are of the best. A York stone is sometimes used for small openings by fixing it into the main wall and letting it overhang to the proper depth of the hearth as well as the length. In some cases it is supported by brick corbels, which are built in the face of the wall the under side of the stone. These corbels come within the depth of the floor joists.

Fender Walls.—These are built to support the hearth, and in some cases they also support part of the floor plate and joist.

Sleeper Walls.—These are built to carry floor plates on which the floor joists rest. They are also adapted for the purpose of ventilation under the floor, and are constructed in a number of ways in which various holes are shaped in different patterns for this purpose.

Fender and sleeper walls only occur in underground floors of wooden construction. Fender walls should always be constructed 9 inches in thickness. Sleeper walls are sometimes 4½ inches and sometimes 9 inches in thickness; if any extra depth above the ordinary is required, the sleeper wall should be 9 inches in thickness, this gives a firmer construction to the floor.

Jambs.—The next detail in the formation of the fireplace is the construction of the jambs. These are attached piers built up on each side of the fireplace opening. They vary in thickness and projection from the main wall into the room, according to the type of stove or grate which is used. When the jambs project 9 inches from the wall they must be at least 9 inches wide. The opening between the jambs will have to be bonded or tied together by means of an iron chimney bar if the opening at the top part of the jambs is arched over with a brick. This is provided to carry the brickwork above the arch. This part of the brickwork, which forms the face of the wall above the opening, and also covers the flue, leading from the fireplace upwards, is called the *breast*. The breast varies in its internal construction according to the number of flues that are required. The jambs are built solid on each side of the opening on ground floors. On the first floor they vary, one or both being hollow. For instance, if there is only one fireplace on the ground floor against an external wall, one of the jambs only would be hollow, the one which takes the formation of the flue from the ground floor. This may be either on the left or on the right hand side of the opening. Where there is a double fireplace on the ground floor, that is to say, a fireplace each side of a party wall, the jambs on the first floor would be the same, viz. one solid and one hollow at each side of the party wall. The jambs would, however, be wider in construction, owing to the formation of the flues internally on the first floor. On the second floor both jambs would be hollow, one taking the flue from the ground-floor fireplace at one side of the opening, and one taking the flue from the first-floor fireplace on the other side of the opening. If we go higher, to the third floor, we shall have to construct wider jambs, because one jamb on one side of the opening will have to take two flues, viz. one from the ground floor and one from the first floor on one side of the opening, and the jamb on the other side of the opening will take the flue from the second floor, the other part of the jamb being built solid, so as to correspond to the same width as the opposite jamb. On the fourth floor both jambs would again correspond with each other in width and internal construction, both containing two flues at each side of the opening.

Chimney Bar.—The upper portion of the fireplace is covered with a brick arch supported by a chimney bar. Fig. 245 illustrates a detail of the chimney bar in position across the fireplace opening. This bar is usually about 2 inches to 3 inches in width, and from ½ inch to ¾ inch in thickness, and spans the opening with an extra 1 foot 6 inches in length to form a 9-inch bearing on each jamb. The ends of the bar are either turned up or down, so as to form a grip in the cross joint, or split at the end longitudinally, and the halves turned in different directions and housed, or bedded, in the brickwork. A skewback is then cut for the arch on each jamb and a rough arch constructed over the opening, the bricks resting on the iron bar. This arch should be carefully constructed and all the joints should be of uniform thickness. The internal portion behind this arch should then be formed. This part forms the mouth of the flue.

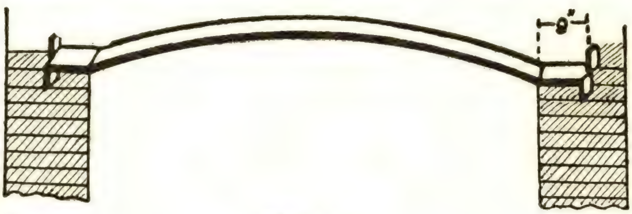


FIG. 245.

Reinforced concrete lintels are sometimes used to cover in the span at the top of the fireplace opening between the jambs. These are often made 9 inches in depth and 4½ inches in width, and rest on the jambs each side 4½ inches to 6 inches.

At the back of the breast just above the arch the mouth of the flue is formed by gathering the bricks over from each side. This means that the brickwork on each side is projected or corbelled over about 1¼ inches each time until the required dimensions are obtained, and the constructing of the flue proper is commenced at this point. It should be inclined either in a right or left direction according to the position it is going to take on the first floor.

All jambs formed on the ground floors must be built upon proper footings, which should be bonded into the main wall or party wall to which they are attached.

The chimney breasts, that is, the portion of brickwork above the opening and jambs, should also be properly bonded into the main wall, and should extend to the ceiling the whole length of the opening and jambs. Chimney breasts are sometimes narrowed on upper floors for the sake of economy, but this method of construction looks very unsightly.

Flues.—The back wall of the fireplace in an external wall must be at least 4½ inches in thickness. Great care must be taken in such instances to bed the bricks solidly. It is also necessary that the bed joints and cross joints in this portion of the wall should be solidly filled in to prevent the escape of smoke, etc. To ensure this the internal face should be rendered. The back walls of all fireplaces constructed in party walls must be at least 9 inches in thickness for at least 1 foot in height above the opening of the fireplace. This thickness of the back wall also applies to kitchen ranges, but in this case the height of the back wall is greater and must be taken much higher, viz. 6 feet at least above the fireplace opening, the 9-inch thickness to be maintained up to that height.

The walls which cover the flues must be at least 4½ inches in thickness. This applies to various positions in which the wall covers the flues, starting with the jambs, breasts, parts of external walls, and finishing with the chimney stacks.

Figs. 242 and 243 give elevation and section of a fireplace opening on the first floor. These will give the positions of the various parts that I have mentioned. Fig. 242 is a section of the fireplace opening, the lower portion showing the trimmer arch, with concrete filling above it, and a 3-inch York stone bedded on the concrete which forms the hearth. This, as will be seen, finishes at the same level as the surrounding floor. The back wall of the fireplace is shown, which is 9 inches in thickness. The chimney bar is indicated by arrow mark. Above this is shown the brick arch supported by the bar. Then we have the shelf which is built into the wall, and shows a projection of 12 inches into the room. Above this is shown that portion of the brickwork known as the breast, and internally between this and the external wall is shown the formation of the flue. The elevation in Fig. 243 shows the width of the opening with the jambs at each side, the chimney bar in position which supports the two-ringed rough arch, and the dotted lines above this show the formation of the mouth of the flue, the line of the flue taking a direction to the left hand side of the breast. The left hand jamb in this case contains a flue 14 inches by 9 inches and the right hand jamb contains a flue 9 inches by 9 inches. These plans are shown in Figs. 244 and 241. The bond in these two illustrations is also shown. Fig. 244 illustrates the bond of the external wall and flues on one course. Fig. 241 illustrates the bond on the next course, the bond being single Flemish bond. Fig. 244 also shows the position of the trimmer joists, and Fig. 241 shows the position of the hearth when finished. The back external wall to the fireplace is 9 inches in thickness.

For the prevention of fire certain by-laws are made in relation to building timber walls, or near walls or hearths in close proximity to the fireplace. No timber, wooden plugs, or wood fixtures of any kind must be built into any brickwork nearer than 9 inches to the inside wall of any fireplace or flue. Timber should not be built into the brickwork under the surface of the hearth nearer than 15 inches to the surface of the hearth. Nor must it be built in any brickwork nearer than 6½ inches from the internal face of the flue or fireplace. This applies to flues of which the external walls are 4½ inches.

Size and Formation of Flues.—The size of the ordinary house or cottage flue is 9 inches by 9 inches. There are some local authorities which still insist on the flue being made larger, viz. 14 inches by 9 inches. No definite size of a larger sized flue than the 9 inches by 9 inches flue is laid down in the Local Government Board's model by-laws for the ordinary house flue. Each fireplace should have a separate flue, which should be of such a size as to carry off the smoke effectually to the external atmosphere. All flues should be properly bonded into the breast wall. The front 4½-inch breast wall which encloses the flues is built mainly with stretching bond, except at the points where the breast wall bricks are bonded into the wall to form one or other of the sides of the flue. Headers are generally placed at these points for this purpose. If the flue runs at an inclined angle in the internal part of the breast wall, the headers are again used for the purpose of bonding into the sides of the flue. The bond will have to be arranged accordingly on the face of the breast wall for this. When the internal flue is built at an angle, the bricks on the lower internal face of the flue are stepped back each time, the distance being determined according to the angle of the incline. In the upper internal face of the flue the construction is somewhat different. Instead of the set-backs in the courses of bricks as in the lower internal face, the bricks in each course project. Care should be taken in these projecting courses to work the proper bond to enable a good tie in every other course to take place in which the headers, part of which are projecting on the top internal face of the flue, should bond into the breast wall. These bricks would show on the face of the breast wall as headers. When constructing these projections in the flues for inclined surfaces, the bottom corner of the projecting brick is cut. This makes the under surface easier to parge, and this method does not take so much material as the other, where you get larger angular voids, which have to be filled in in order to obtain a finished surface to the flue. These voids take a considerable amount of material, and if the bend is at a sharp angle, there is a danger of the material falling into the flue from these angular fillings. Sometimes the top portion of the flue is covered in by bedding pieces of York stone which rest on each side of the flue. This does not form such a strong construction as the bricks when laid solid and properly tied or bonded in the breast wall. When bends in the formation of the flue have to be constructed, they should be made as easy as possible, continuous, without nearly horizontal sections or pockets. These bends in the flues tend to prevent downward currents of air, known as down draughts, but if the flues are too sharply bent, or have platforms, these tend to retard the upward flow of smoke to the external atmosphere, and if near the top of the house, and the rain gets into them, it encourages the formation of a spongy mass of soot at the bottom surface of the sharp bend in the flue, and, in time, this is liable to choke the flue and prevent the free passage of upward smoke from the fireplace opening. Moreover if the flue is so constructed that platforms or pockets (traps for soot) are formed, rain will lodge and ultimately soak through the wall, forming internal damp patches and stains.

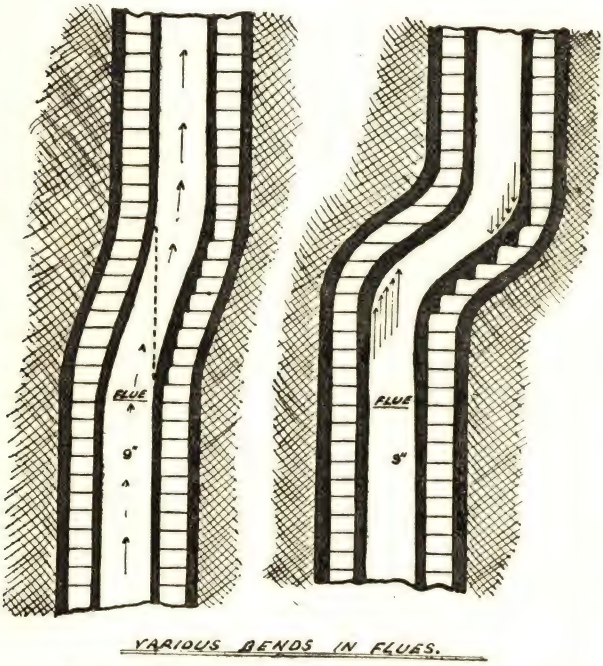


Fig. 246.

Fig. 246a.

Fig. 246 shows how the flue should be formed with an easy bend. By the upward arrow marks, it will be seen that from bottom to top there is an easy unobstructed flow for the smoke to the external air, the vertical dotted line showing the upper left hand portion of the flue, which covers the flue in the lower portion.

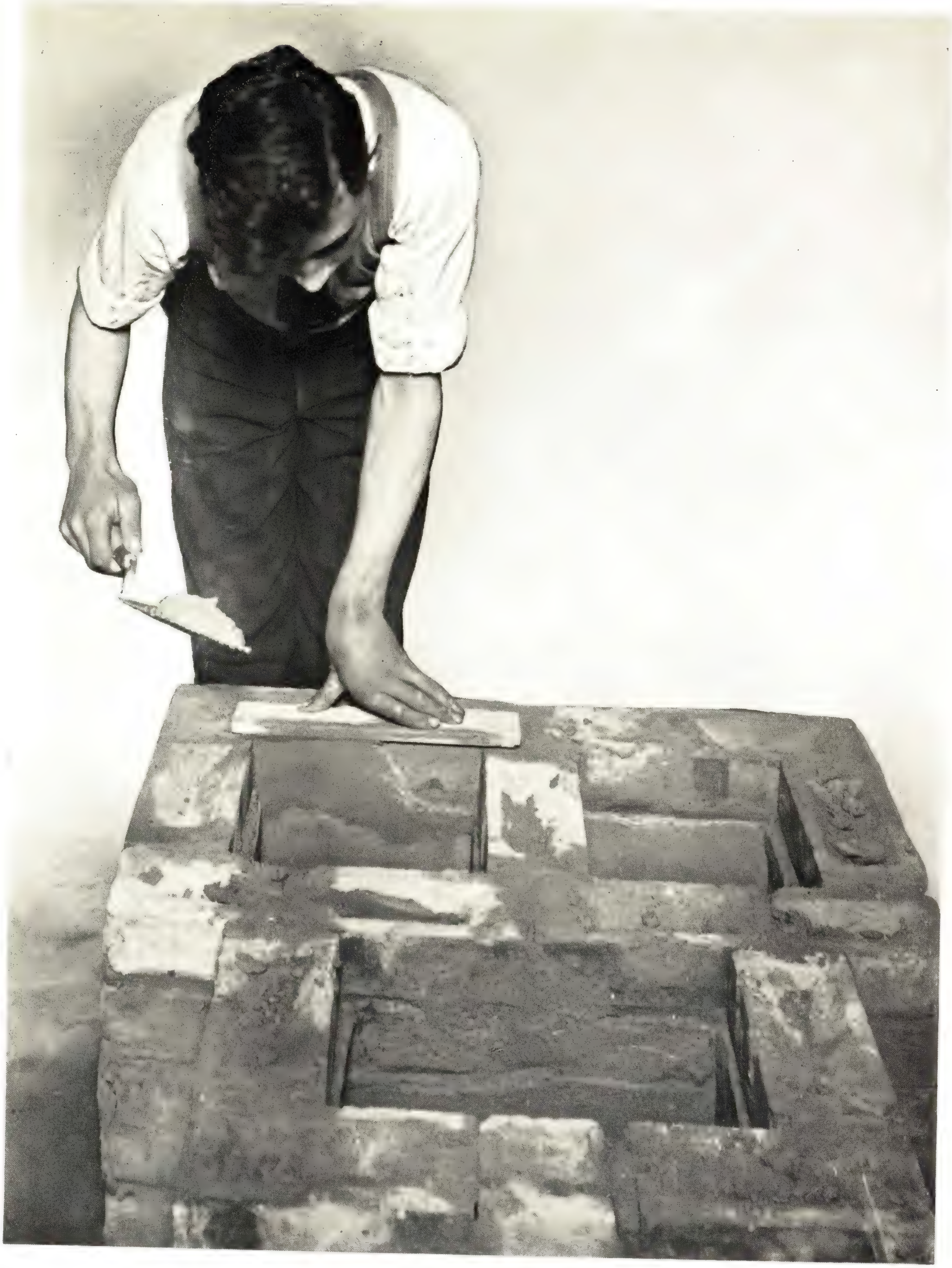
Fig. 246a is an illustration of a very sharp bend in the formation of the flue. This formation undoubtedly retards the flow of smoke in its upward direction. The upper arrow marks also show a ledge-like construction formed in the flue, on which, as mentioned, soot would have a tendency to settle, especially at the time of sweeping the flue, and in time would cause trouble at this point in the manner just described. Flues which are too large often smoke. The smaller the flue is constructed to be practically efficient, and the longer its length, the less it will smoke. Being a good length, the draught will be greater to draw the smoke to the external air. The flues that smoke most are usually the short ones in the upper stories of the house. Flues should, as far as possible, be grouped together, as this saves labour and material while ensuring greater efficiency.

Pargetting and Lining of Flues.—This is for the purpose of making

PLATE

PARGETING CHIMNEY FLUES

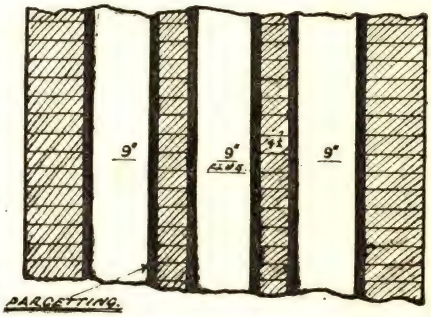
An operative is here seen pargeting a group of three flues in a chimney stack. The external walls of 4½-inch brickwork enclose flues of unequal dimensions, one 9 inches by 14 inches, and two of 9 inches by 9 inches. Having taken material on his trowel from the mortar board he is about to apply it to the interior surface of the flue, working it to an even thickness and smooth face, to do which he works from a short straight-edge pressed down by his left hand over the edge of the flue, held in a position to the desired gauge.



PARGETING CHIMNEY FLUES.

the flue airtight, so that it shall not be affected, to any great extent, by the external atmosphere, and so lose its efficiency by the external atmosphere entering at any lose or porous joints, which would lower the temperature in the flue. The lining (of whatever material it is composed) forms a smooth surface on the face of the rough bricks, and so gives an unrestricted and free passage, offering very little resistance to the ascending smoke from the fireplace. Flue linings are composed of various materials, the most common being cement mortar, the operation being called pargetting. They should be placed on the internal wall with the brick trowel. The materials should be well pressed in any holes or faulty joints, and well trowelled to form a smooth finish. All internal corners should be rounded, and the material should be about ½ inch in thickness. The material should be placed on the internal walls of the flue, and finished every 12 inches or 18 inches as the work proceeds.

Figs. 246 and 246A show the internal rendering of the flues. Another material which is used on the internal surfaces of flues in cottage building is lime mortar. This material should be allowed to stand for a few days before being used for this purpose. If used too fresh, there is the danger of the smaller particles of lime blowing, if the lime is not thoroughly slaked. This causes holes, which make a rough surface, and is liable to let cold air into the flue from the external atmosphere, while it also retards the free passage of the upward smoke to the external atmosphere.

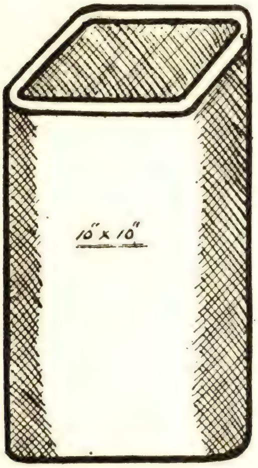


SECTION OF THREE 9" FLUES.

FIG. 247.

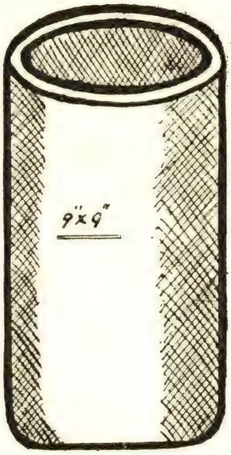
The old method of parging or pargetting, as it was sometimes termed, consists in the use of a material composed of lime mortar and cow-dung, in the proportions of 3 or 4 parts of mortar to 1 part of cow-dung. This form of pargetting the flues provided a good substantial lining and lasted for many years. I have come across various samples of it in London of recent years, and it has been in quite a good state, though some of these houses were 100 years old or more.

Fig. 247 is an illustration of three flues with the pargetting showing in the internal walls of the flues. Other materials have, of later years, been used for the lining of flues, such as fireclay lining pipes. These are made in various shapes, square, oval, and circular, to suit the various sized flues. Figs. 248 and 249 give two illustrations, the one square and the other circular. These fireclay linings are generally fixed in position a little beyond the mouth of the flue, and the brickwork built solid all round them. Short lengths can be obtained so as to form an easy bend in the formation of the flue, though bent pipes are also obtainable. Care should be taken to bed out joints each end of these linings, to butt them firmly together and to fix them cylindrically uniform internally throughout the length of the flue, and to leave no internal ridges. This method of construction forms a good, smooth, durable flue.



RECTANGULAR SHAPE

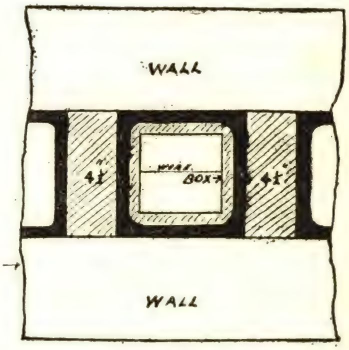
FIG. 248.



CIRCULAR SHAPE.

FIG. 249.

Fig. 250 shows another method of pargetting, which is performed by using a wood box frame, with a piece of wire fixed across the centre of it for handling purposes. The external size of the box is made ⅝ inch smaller than the internal face of the flue. This space between the outside of the box and the inside face of the flue allows material to be placed there, to form an inside lining to the flue. The box is 12 inches in depth, and is placed in position after the brick flue has been constructed. The space between is then filled in solidly with cement mortar, which forms the lining or pargetting to the flue. The box is then lifted in an upward direction, and the next 12 inches is constructed in the same way. This method saves a lot of material, which, by the ordinary method of pargetting, usually falls down the flue, however careful the bricklayer may be in using it. The external corners of the box are rounded in shape so as to give the round shape to the internal angles of the lining of the flue. The piece of wire, as seen, is used for lifing the box upwards. The shaded portions show the two 4½-inch walls or withes which divide the flues.



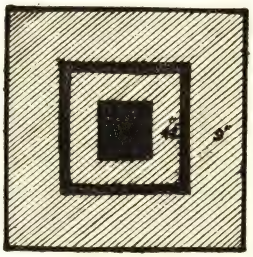
PLAN SHOWING BOX USED FOR PARGETTING.

FIG. 250.

Fig. 251 is an illustration of the plan of a boiler flue, showing the method of lining. In this plan, a 9-inch wall forms the external part of the chimney. Inside this 9-inch wall, there is a cavity of 1 inch. Inside the side of this cavity, and forming the flue proper, is the lining of the flue, which is constructed of 4½-inch firebricks, bedded in fireclay. The internal size, as shown, is 9 inches by 9 inches. These internal lining walls are sometimes tied into the external wall by placing a stretcher brick across the cavity; these are placed at various intervals. This holds the 4½-inch internal part in a firm position.

The bends of the flues are sometimes constructed with short lengths of stone, which cover the width of the flue at the top and bottom. These are mitred at their ends and butted together to form the bends. The internal joints to these stones should be solid and smoothed off on the internal face of the flue. Sometimes a strip of slate is placed and bedded on the external part of the joint This ensures the joint being airtight. Bends are also formed in the flues by mitring the ends of the fireclay tube linings, which are made in short lengths for the purpose. Very often flues are constructed entirely of stone slabs, especially in districts where stone is plentiful, but this construction does not give the same strength as the brick flues, because of the difficulty in proper bonding.

Soot Doors.—Soot doors are sometimes fixed at angles; they may be constructed at any angle, but must not be less than 40 square inches. The incline of the flue should not be less than 45 degrees to the horizon, and every angle must be rounded, that is, parged, and made easy at any abrupt angles. When fixing the soot door remember it must be at least 15 inches distant from any woodwork. The soot door consists of an iron frame and hinged door, which when opened gives access to the angle of the flue, to enable it to be cleaned out at various periods. There are generally four projections at each external angle of the frame, these are called lugs; these projections give a good fixing to the frame when built in the brickwork.



PLAN OF BOILER FLUE WITH
4½" FIRE BRICK INTERNAL LINING,

FIG. 251.

Chimney Stacks.—The chimney stack is that portion of brickwork which encloses the flues above the exterior surface of the roof. The minimum height for stacks above the roof must be 3 feet above the highest point of the roof. Nine-inch brickwork externally offers the best protection from the elements and keeps the flues airtight. The same point applies to stacks when passing through the roof. Then, again, the 9-inch brickwork to all external walls is a better protection against fire. Where there is timber in close proximity, if built with 4½-inch external walls, when passing through the roof it should be well rendered externally. The same need for precaution applies to that portion between the ceiling of the last floor and the roof. All external walls to chimney stacks which are above the roof should be built in cement mortar and the bricks solidly bedded and all joints to brickwork thoroughly filled. This gives the stack protection from the weather. The top part of the stack should be well weathered. This is done in a variety of ways.

Fig. 252 is an illustration of the weathering at the top part of the chimney stack. Oversailing courses are generally used for the purpose. This detailed diagram shows three oversailing courses projecting on the face of the external wall of the stack. One course is placed on the top oversailing course showing two courses in a perpendicular position on the face of the wall. Above this two courses are set back in a perpendicular position; these being set back, allow for a cement weathering which is in the form of a cement fillet. This should be well pressed into the internal angle of the course which is set back from the oversailing course, and well trowelled and finished at an angle of 45 degrees. Any chimney pots should be well bedded and fixed in a perpendicular position. The top of brickwork should then be weathered well with cement and sand. This method of weathering is also called flounching. This should be well pressed and trowelled and made as impervious as possible, chiefly as a protection against dampness, which may penetrate in a downward direction into the stack, if not done in a thorough manner. The oversailing courses protect the external walls of the stack, the weathering throwing off any moisture which may accumulate on its surface in an outward direction, clear of the surface of the wall below it. Tiles also are used for the purpose of forming projections or oversailing courses. Three double courses of tiles when used for this purpose produce a good facial effect. Sometimes the top weathering of the chimney takes the form of a stone, or concrete cap, holes being made and shaped for the pots to be placed into position, and the external top surface inclined outwards to form a good weathering. Chimney pots are fixed on the stacks to obtain a greater draught, which being of a smaller sectional area tend to increase the draught, and so give a greater velocity to the upward current of smoke.

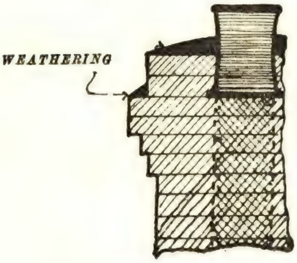


FIG. 252.

The Coring of Flues.—When the construction of the flues is complete, care has to be taken to ascertain that all the flues have a free unobstructed passage, also to remove any surplus material which may have been left on the internal faces of the flue, and also to clear any material which may have been dropped and settled at the various bends of the chimney. Coring is sometimes performed as the building of the flues progresses, and sometimes left till the completion of the flues. Coring is usually performed by means of a rope which is tied to a sack filled with straw or other soft material. This is placed at the beginning of the flue above the mouth. About 6 feet of this portion from the sack downwards can be easily cleared by hand. The sack fits tightly against the sides of the flue and prevents any material which may be dropped during the operation of parging the flue from dropping below this point. When the flue has been finished for a considerable height above this point, the sack is pulled upwards and the surplus material which rests on it is taken off and the sack again replaced for further use. The same method is sometimes used directly after the flue is completed, but this is not so effectual as the first method, as there may be portions of material which, having set hard,

PLATE

THE HANDLING OF TOOLS IN THE CONSTRUCTION OF A CHIMNEY STACK WITH VARIED PROJECTIONS

An ornamental chimney stack, showing four projections of 4½ inches on each point and two at each end. These vertical projections are carried up to horizontal oversailing courses, the centre one being a dog-tooth course, formed by bricks laid at an angle of 45 degrees to the face of the wall, the top one with the vertical face of the brick level with the vertical angles of the bricks below. The operative at the back of the stack is placing a brick forming its withe between the flues, tapping it down with the butt-end of his trowel handle. The bricklayer on the left, having spread a layer of mortar, is about to bed the quoin in position, holding his trowel ready to remove surplus mortar. On the right an operative is seen manipulating the plumb-rule.

the sack in passing cannot remove. Again, if there are portions of material accumulated in bends, etc., it requires more than the sack to remove them. In these cases a lead or iron ball attached to a rope is dropped into the flue and bumped against the surplus material until it is removed. At times if the first method is not used, there is often a complete block in various places in the flue. This is due to carelessness on the part of the workman. In such a case the flue is tapped at various points to find the solid mass of material, which is then cut out at this point and the flue cleared. Or else the blocked portion is found by measuring with a rope or rod, which is let down the flue in order to find the exact spot. Coring holes are sometimes left at various positions in the length of the flue, and a coring board is placed at an incline which enables any surplus material falling to slide out on top of this board. Prevention is better, less costly, than cure in all these cases. By using the coring sack with rope attached it will save a lot of trouble in clearing the flue afterwards. It is best to use it as the work proceeds and is also the cleanest way.

Bond in Chimney Stacks.—The chimney stacks should be well bonded and only good material used in conjunction with sound craftsmanship, so that they may be capable of withstanding the elements to which their positions expose them. It is always best to have a 9-inch external wall to the stack where it is possible to do so. There are various bonds used in the formation of the chimney stack, English and Flemish being used in the 9-inch external work, Flemish and stretching bond being used in the 4½-inch external work.

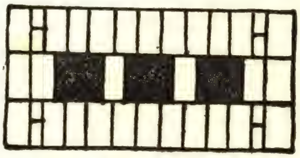


FIG. 253.

Fig. 253 is an illustration of the plan of a stack built in English bond, containing three flues each 9 inches by 9 inches. The two external side courses contain headers all through the course with the exception of the closers next to the external angle headers. Three stretchers are placed at each end, forming the English bond stretching course. Two stretchers are placed at the back of these. This forms the 9-inch wall at each end, and in the side of the 9-inch by 9-inch flue at each end two headers are placed in position between the flues, thus forming the three 9-inch by 9-inch flues.

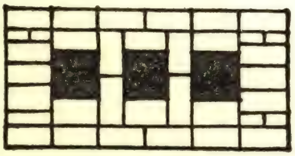


FIG. 254.

Fig. 254 is an illustration of the plan of the next course in the same stack. The bricks are also laid in English bond. The two sides this time are formed with stretchers and backed up with stretchers, except at the points where the internal 4½-inch walls are formed (the withes). These are backed against the external stretcher and form a 4½-inch tie over the preceding brick in the withe, resting 4½ inches on the external wall and 4½ inches on the withe brick in the course below. These bricks form a good tie and bond the external wall into each withe.

Fig. 255 is an illustration of the plan of a stack in which the bricks are again laid in English bond, the stack this time containing three 14-inch by 9-inch flues. The two sides of the stack are constructed in a heading course. The sides consist of a stretching course, being an uneven number of whole bricks or stretchers in the side of the stack, the remaining half being the header, therefore there is only one stretcher on the external face which is backed up by another stretcher. This completes the 9-inch walls at each end of the stack. The two withes are composed of two three-quarters in each case, making the flue 14 inches in length, or one and a half bricks.

Fig. 256 is an illustration of the plan of the same stack showing the bonding of the next course. The sides in this case are stretchers, and at the points where the flues are formed they are backed by internal stretchers. At the points where the withes are formed an internal header is placed at the back of the external stretcher. This forms a 4½-inch bond half resting on the external wall on the half surface of two headers below it, the other half resting on the withe wall, resting on two-thirds of the three-quarter brick below it. The two centre portions are filled in with two half bricks or bats. This also forms a good bond in the stack in conjunction with the English bond being used with the three 14-inch by 9-inch flues.

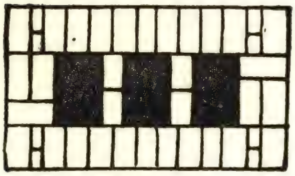


FIG. 255.

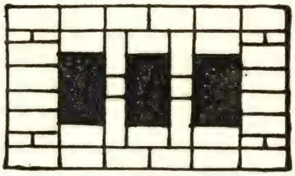


FIG. 256.

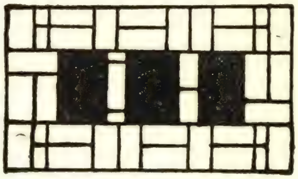


FIG. 257.

Fig. 257 gives a plan of a chimney stack with 9-inch external walls, containing three 14-inch by 9-inch flues and the bricks laid in Flemish bond. In this plan it will be noticed that the Flemish bond is laid all round the external wall. The withe walls show two examples of bond; the left hand withe consists of two three-quarter bricks making the length of flue, which is 14 inches, and the right hand withe consists of a stretcher in the centre, with a closer fixed at each end, also making the 14 inches or length of the flue. I think the left hand formation of the withe is the stronger of the two, because it does not contain so many cross joints as the other. Fig. 258 illustrates the plan of the next course in the stack, which shows the weakness in Flemish bond compared with English bond. In the internal 4½ inches of the wall, there are a number of bats. Also, there are a number of straight joints which are formed by the Flemish bond in the internal portion of the external wall. The

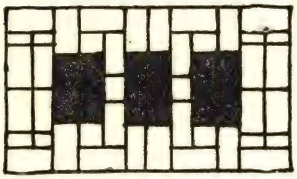


FIG. 258.

withes are tied into the external wall by the whole brick, which rests half on the withe and half on the external wall, but the end of this forms a straight internal joint when the stretcher in the course above is placed in position on the external face of the wall, therefore there are many weak points in the construction of Flemish bond for chimney stacks.

Fig. 259 shows the plan of a stack built in stretching bond, with 4½-inch external walls, containing one 14-inch by 9-inch and two 9-inch by 9-inch flues. The bond of the two sides contains four stretchers and two three-quarter bricks; the two ends contain two headers, the middle stretcher forming the sides of the end flues, two internal stretchers forming the other sides of the end flues and the middle flue. Fig. 260 shows the plan of the second course, the bricks also laid in stretching bond, two stretchers on either side being splayed at an angle of 45 pegrees, in order to break the joint over the three-quarter in the course below. Two stretchers show at each end of the stack. Fig. 261 is an illustration of the plan of a stack containing 4½-inch external walls, built in Flemish bond, and composed of three 14-inch by 9-inch flues. The sides of the stack in this course contain four stretchers and three half bricks; the ends, two headers, two closers, and a stretcher in the centre. The withes contain one stretcher and two closers in each. There is a lot of cutting and waste to this form of stack. Fig. 262 is an illustration of the second course of this stack; the headers in the sides of the stack form a good tie into the withes, half being on the withe wall covering the closer, and a quarter of the withe stretcher. The ends contain the correct Flemish bond, stretcher, header, stretcher.

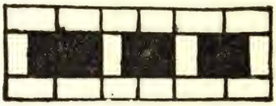


FIG. 259.

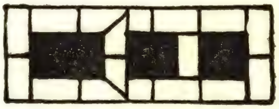


FIG. 260.

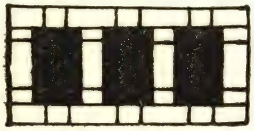


FIG. 261.

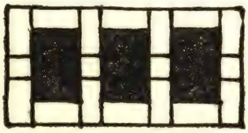
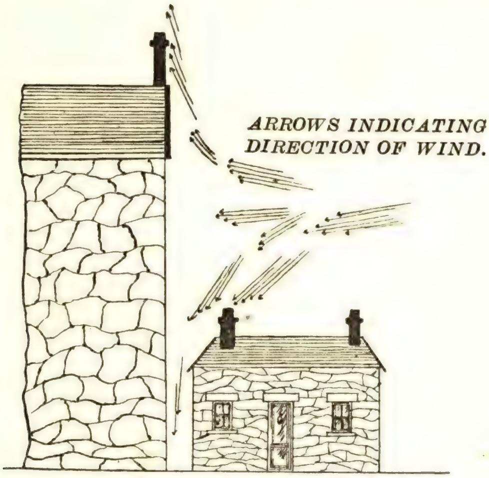


FIG. 262.

Smoky Fires.—Smoky fires, or as we more often say, smoky chimneys, occur through a number of causes, among these being atmospheric conditions, high buildings causing down draughts on lower buildings in close proximity; high trees overhanging or close to a building; accumulation of soot in the chimney. But when we examine all these causes, and finally get to the root of the matter, in a good many cases we find that the cause of this trouble is the bad construction of the flue.

Atmospheric conditions sometimes induce a down draught and cause the smoky chimney. Wind and rain cause trouble in this direction, and no matter how thoroughly a chimney has been constructed, it will at times smoke, due to change of wind. When winds are in certain directions, the trouble in these two causes (over which we have no control) does not last long, in most cases only for a few hours, until the direction of the wind changes. Proper placing of chimneys, by arranging them practically level with each other, avoiding a tall chimney in close proximity to a short one, and providing pivoted cowls with wind vanes, will mitigate the nuisance. When short stacks are near tall ones, the short ones would probably suffer a down draught caused by the smoke of the tall ones, as indicated in the illustration, Fig. 264. A similar nuisance occurs when a low building is erected close to a tall one; then various currents are induced as shown by arrow points in Fig. 263. The narrow space between the two buildings would probably draw and cause a draught, because the wind, in being drawn down to this point, would sweep over the chimney of the lower building, giving rise to a severe down draught.



ELEVATION OF TWO BUILDINGS.

Fig. 263.

The wrong size of flues in their construction will often cause smoky fires. The sectional area of all the flues should be of a size that will carry off the smoke effectually to the external air. The 9-inch by 9-inch flue for all house fires is an effectual size. A larger flue will have the effect of retarding the smoke in its upward direction. The larger the flue, the more cold air will it contain; and the heat of the ordinary fire not being great enough to displace this column of cold air quickly, so giving the upward passage of smoke an easy flow upwards to the external atmosphere, the smoke is retarded by this pressure of cold air. The chimney must also be a uniform sectional area throughout the whole length of its course. Narrow places in the formation of the chimney (called cramping) will retard the flow of smoke in its upward course, and cause the chimney to smoke. The only place where the cramping of the sectional area of the chimney is beneficial is at the extreme top. This tends to draw or quicken the upward flow of smoke.

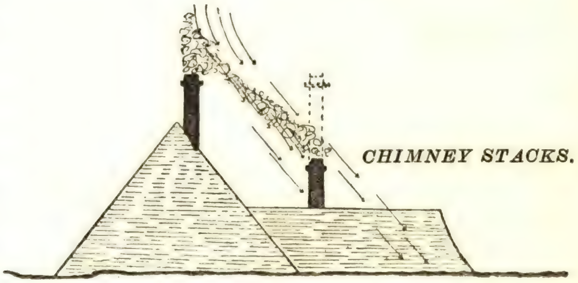
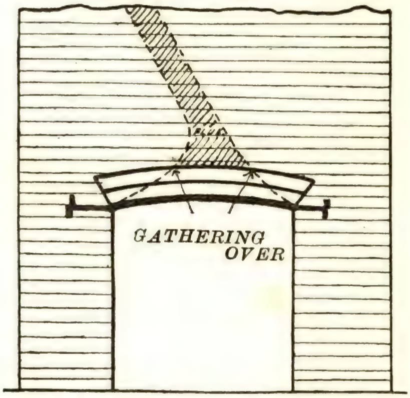


Fig. 264.

Furnace chimneys, where there is a greater amount of heat to displace the cold columns of air in the chimneys, must be made larger, 12 inches by 12 inches being a common size for a hotel kitchen chimney containing a large range, or a chimney from a furnace.

Very sharp bends in chimney flues will also retard the flow of smoke, and cause a smoky fire. Fig. 265 shows the proper direction of the flue from the mouth at the top of opening, the wing gathering shown by dotted lines running from each side at an internal point top of the chimney bar level. Two flues which sometimes are connected with each other very often cause a smoky chimney, especially if the two fires are burning at the same time; the smoke from the top fire ascending the chimney will retard the flow of the smoke from the bottom fire, eventually ascending into the same chimney.



ELEVATION SHOWING GATHERING OVER OF CHIMNEY FLUE.

FIG. 265.

The London Building Act, 1930.

Section 69.—1. Chimneys built on corbels of brick, stone, or other incombustible materials, may be erected if the work is corbelled out and does not project from the wall more than the thickness of the wall, measured immediately below the corbel; but all other chimneys shall be built on solid foundations and with footings similar to the footings of the wall against which they are built, unless they are carried upon iron girders with direct bearing upon party, external, or cross walls, to the satisfaction of the District Surveyor.

2. Chimney and flues having proper soot doors of not less than 40 square inches may be constructed at any angle, but in no other case shall any flue be inclined at a less angle than 45 degrees to the horizon and every angle shall be properly rounded; all soot doors shall be at least 15 inches distant from any woodwork.

3. An arch of brick or stone or bar of wrought iron of sufficient strength shall be built over the opening of every chimney to support breast if breast projects more than 4 inches and jambs less than 17½ inches abutment shall be tied in by iron bar or bars, turned up and down at ends and built into jambs at least 8½ inches.

4. Flue must not be adapted to or used by any new oven, furnace, cockle, steam-boiler or close fire, used for any purpose of trade or business, or for range or cooking apparatus, tavern or eating house, unless flue is surrounded by brickwork at least 8½ inches thick from floor on which such oven, furnace, cockle, steam-boiler or close fire is situate to level of ceiling of room next above same.

5. Flue not to be used in connection with steam boiler or hot air engine unless flue is at least 20 feet in height measured from level of floor on which placed.

6. Inside of flue and outside where passing through floor or roof or behind or against any woodwork to be rendered.

7. Position and every course of flue shall be distinguished on outside of work as it is carried up by outline marks, except when exterior face of flue forms part of external wall not likely to be built against.

8. Jambs to be at least 8½ inches wide each side of opening.

9. Breast and brickwork around every smoke flue to be 4 ins. thick.

10. Back of fireplace in party wall from hearth 12 inches above mantel shall be at least 8½ inches thick.

11. Thickness of upper side of every flue when angle of less than 45 degrees must be 8½ inches.

12. Shafts at least 4 inches thick to a height of not less than 3 feet above roof, flat or gutter measured at highest point of juncture.

13. Highest six courses of shaft or stack shall be built in cement.

14. No shaft to be higher above roof flat or gutter from highest point than six times the least width unless built with and bonded to another shaft not in same line or otherwise rendered secure, except furnace of steam engine, brewery, distillery, or manufactory.

15. Slab to be of stone, slate, or other incombustible material 6 ins. longer than opening on each side, and 18 ins. wide in front of breast.

16. Slab to be laid wholly on stone or iron bearers or brick trimmers or other incombustible materials, but on lowest floor may be bedded in concrete covering the site.

17. Hearth or slab to be solid for a thickness of 6 inches at least beneath upper surface.

18. Flue not to be built against any party structure unless surrounded with new brickwork 4 inches thick properly bonded.

19. No chimney breast or shaft, or any party wall, to be cut away unless District Surveyor certifies it.

20. A chimney shaft jamb breast or flue shall not be cut into except for the purposes of repair or of any of the following operations :—

(*a*) letting in or removing or altering flues pipes or funnels for the conveyance of smoke hot air or steam or letting in removing or altering smoke jacks ;
(*b*) forming openings to be fitted with a close iron soot door and frame ;
(*c*) making any opening for the insertion of ventilating valves if the opening is not made nearer than twelve inches to any timber or combustible materials.

21. Timber or woodwork shall not be placed :—

(*a*) in any wall or chimney breast nearer than twelve inches to the inside of any flue or chimney opening ;
(*b*) under any chimney opening within ten inches from the upper surface of the hearth of such chimney opening ;
(*c*) within two inches from the face of the brickwork or stonework about any chimney or flue where the substance of such brickwork or stonework is less than 8½ inches thick unless the face of such brickwork or stonework is rendered.

22. Wooden plugs shall not be driven nearer than six inches to the inside of any flue or chimney opening nor any iron holdfast or other iron fastening nearer than two inches thereto.

Furnace Shafts.—These must be—

(1) Constructed of the best materials and workmanship.

(2) If detached, at minimum rate of 2½ inches per 10-foot rise.

(3) Have thickness of brick for top 20 feet of not less than 8½ inches and increase at the rate of half a brick per 20 feet measured downwards.

(4) Have every variation from plain brickwork in addition to minimum thickness allowed and design and construction sanctioned by the District Surveyor.

(5) Have footings spreading by regular offsets round centre base to a projection equal to thickness of enclosing brickwork at base of shaft, the space being filled in solid as work progresses.

(6) If square, have width of base not less than one-tenth, or if circular, one-twelfth of height.

(7) Firebrick lining be treated independently, not being bonded into main wall, or calculated as part of it.

CHAPTER XIII

THE DOMESTIC COPPER

Setting out the Copper—Construction—The Flue—Frames—The Furnace—Bedding the Copper—Building the Copper Walls—Finishing the Flue—Grouting—A 20-gallon Copper—Points to Remember.

THE domestic "copper" is really a small furnace with superstructure to contain a large copper or iron pot in the form of a cauldron. They are mostly used for washing or laundry purposes, but are also found in connection with dairies, in outhouses for preparing cooked foods for live stock, and also as cooking vessels in farm or home industries. Many coppers are built of stone, but brick is the more usual material outside of the Northern and West of England counties.

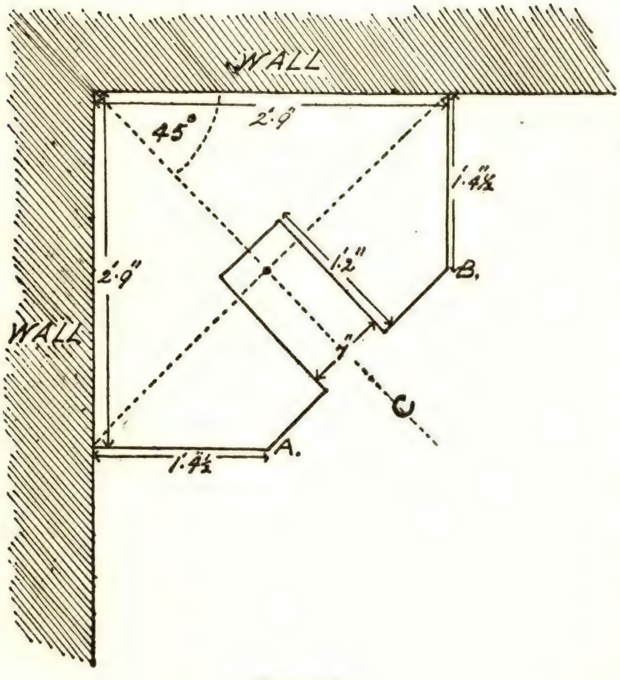


FIG. 266.

They are of considerable importance to most owners, and constantly have to stand hard wear; if, however, constructed with care, and good materials are used, they will remain serviceable for a long period. The parts requiring the most careful attention are the lower part, or face, and the flue.

All materials used in constructing the copper should be sound and durable. Generally good old stocks are best for the brickwork portion, in combination with a well-made lime mortar. The furnace should be formed with firebricks, which should be of a good make. The copper should be strong and well galvanised, while the fittings, namely the firebars, door and frame to furnace, and the soot door, should all be sound and durable.

The copper which is shown in Fig. 266 is built against the two walls of an internal angle. These coppers are usually built in either one of the two shapes, circular or octagonal. The capacity of the ordinary washing copper is about 10 gallons. They are also made in larger sizes up to 20 gallons for ordinary purposes. These are made of galvanised iron or of copper, now reserved specially for factory or workshop use.

Setting Out the Copper.—The usual method of setting out the copper is shown in Fig. 266. The first step is to measure from the internal angle of the wall a distance of 2 feet 9 inches in each direction along the walls, and then square out from this point a distance of 1 foot 4½ inches. This can be done with the aid of the ordinary building square. This brings us to two points A and B, which form the face line of the wall of the copper. The next proceeding is to set out the lines for the ash-hole. This is done by striking a line at 45 degrees from the internal angle of the walls, which can be done by dividing the line AB into two equal parts, then connecting the internal angle point to the centre point of the line AB. This gives us the centre line of the ash-hole.

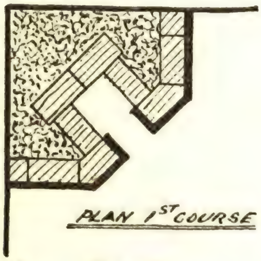


FIG. 267.

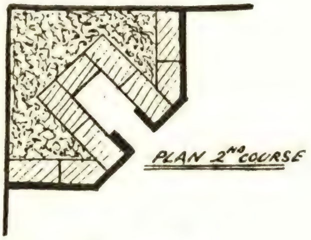


FIG. 268.

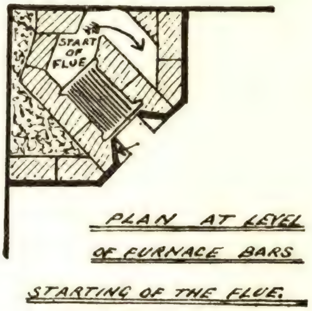


FIG. 269.

Next take a distance from each side of the centre point of line AB 3½ inches. This is 7 inches, the width of the ash-hole. From the face of the line AB take a distance back of 1 foot 2 inches, which line gives us the back part of the ash-hole. The setting out of the copper is now complete and ready for construction.

Construction.—Fig. 267 gives an illustration of the setting out of the first course of the copper, the bricks all being bedded in position, showing the outside walls of the copper and the formation of the ash-hole. Two squint bricks are necessary to form the octagonal shape of the outside walls. The second course laid in position is shown in Fig. 268, and it will be seen that the bricks are all laid to bond, and the squint bricks reversed. The inside portion is sometimes filled with light breeze concrete or brick rubble, which should be thoroughly grouted and made solid. Fig. 269 gives an illustration of the walls at furnace-bar level. At this level the furnace bars are bedded in their proper position. They should be placed 4½ inches back from the face of the front wall of the copper, and rest on either side of the side walls of the ash-hole.

The Flue.—The bricks at the back are now placed so as to start the formation of the copper flue, which starts rising showing from the back of the firebars in a curved direction to the right. The angles where the bricks are placed against each other are parged so as to form a smooth surface on the internal face of the flue. A flue so formed should be of a uniform diameter throughout its length.

Frame.—Round the copper on the furnace bars is fixed the copper door frame. This usually contains four lugs about 6 inches long, two at the top corners and two at the bottom corners. The face of the door frame fits on the front of the furnace bars and the two bottom lugs are held in position by the firebricks. These are bedded inside the frame at each side of the firebars, two or three courses at each side of the firebars forming the furnace. The top lugs of the frame are held in position in the same way as the bottom ones.

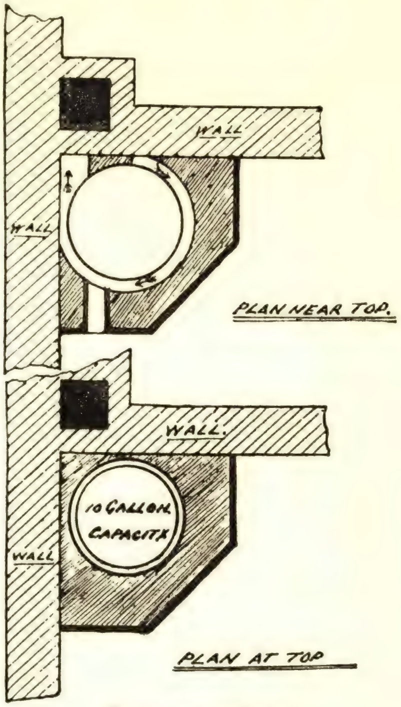
The Furnace.—The firebricks which form the furnace should be bedded in good fireclay with very thin joints. The brickwork in front of the frame is usually splayed at each side, to allow plenty of room for the furnace door to open and shut. A small hole is usually left in the brickwork at the left hand side of the frame horizontally with the door catch, to allow it to work freely when opening and shutting the door. The splay in the front brickwork at each side of the frame is shown by an arrow.

Bedding the Copper.—The copper can now be placed and bedded into its correct position, allowing room for the flue and brickwork, covering in front. The copper must be perfectly level. The bottom of the flue which starts at a level with the furnace bars at the back is brought to a level in the front about 3 inches above the top of the frame. This 3 inches allows for covering on top of the frame, between the back of the frame and the copper.

Building the Copper Walls.—The building of the copper walls can now be proceeded with, and the top of the copper flue can now be started to be covered in, starting from the back near the firebars. The usual method adopted is to build at a parallel distance from the copper as we proceed round the copper (which should be the width of the flue). At the same time, this brickwork should be built at the same rise or incline as the bottom surface of the flue.

Finishing the Flue.—The top of the flue can now be covered by bedding bricks on the inclined brickwork, the end of which are bedded against the copper. As these bricks are laid, care must be taken to parge the flue as the covering proceeds. As the flue proceeds round to the left hand side of the copper towards the chimney flue, the back part of the copper should be blocked off by brickwork. The copper flue can now be formed into the proper chimney flue and covered in. The brickwork which is blocked off at the back of the copper is shown in the illustration Fig. 270. This shows the flue from the furnace bar level to the level of the chimney flue, the block part of brickwork being shown at the back.

Grouting.—To give a good finish, the whole of the brickwork should be well grouted in with grout mortar, filling in all air spaces and holes, so as to ensure that no smoke escapes from the copper flue. The opening in the illustration of plan of copper near the top is the soot door. This is used for cleaning the flue in the direction of the main chimney flue, and also to the right in the other direction towards the furnace. The external face of the brickwork is rendered with ¾ inch of cement and sand, well floated. The top surface round the copper should be inclined towards the top of the copper flanges. Care should be taken to make the work solid round the flange of the copper, to prevent any escape of smoke. Fig. 271 gives an illustration of the finished copper.



FIGS. 270 and 271.

A 20-Gallon Copper.—In Fig. 272 we have a sectional view of a 20-gallon capacity brick copper. The width of the copper is 3 feet, and the height 3 feet. The ash-hole is shown in the centre. This should be a little more in width than the ordinary 10-gallon copper. The setting out of such a copper is quite simple, as it is square in shape. All dimensions can be worked from a centre line, which can be done by placing the building square against the face of the existing wall, and squaring out the line from it. This centre line will be the centre of the ash-hole. The sides of the ash-hole can then be taken from it. The width of the ash-hole is 9 inches. The height from the floor to the furnace bars is 11 inches. The height of the furnace is 6 inches. This furnace should be formed with firebricks, as in the case of an ordinary copper furnace lining. The depth of the copper is 1 foot 6 inches. The external wall of this copper is finished with a struck joint, which should be solidly filled in to prevent the escape of any smoke from the interior of the copper. The top surface is finished with a layer of cement and sand, with a floated surface, which should be 1 inch in thick-

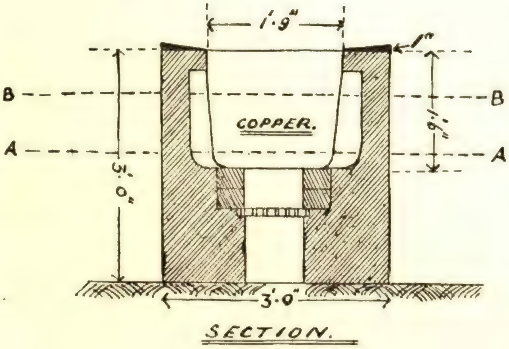


FIG. 272.

ness on the external edges, and sloped towards the flange of the copper. A finish of this kind prevents any water from running down the face of the copper, if the water in the copper happens to boil over and rise above the flanges. The point at the external edge of the flange should be solid and well bedded, to prevent the water gaining access to the internal parts of the copper. The diameter of the copper is 1 foot 9 inches.

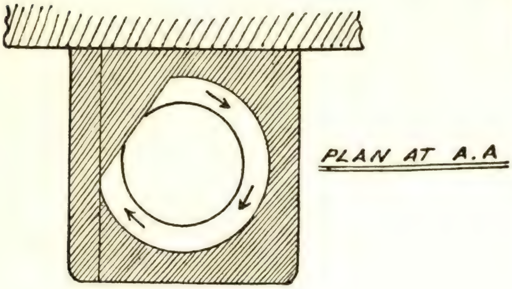


Fig. 273.

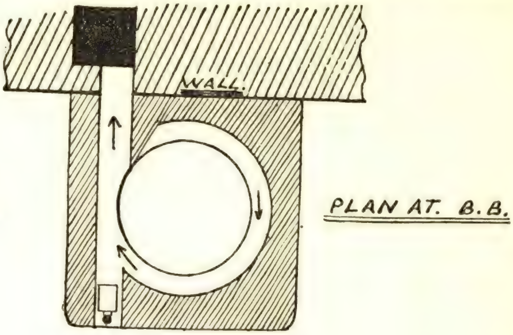


Fig. 274.

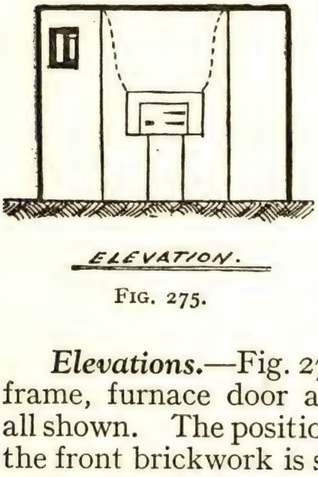


Fig. 275.

Fig. 273 shows a plan marked AA. This position is shown on the section just above the level of the furnace bars. Fig. 274 is a plan marked BB which shows in the section a point nearing the top of the copper. It also shows the soot door at the left hand side of the copper, and the copper flue running into the main chimney flue. The main chimney flue is shown in the main wall.

Elevations.—Fig. 275.—The height and width of ash-hole, the furnace frame, furnace door and also the soot door on the left-hand side are all shown. The position of the copper inside the front brickwork is shown by dotted line, while the thickness of the cement work covering the external brickwork is shown by thick line and the top surface sloping towards the flange of the copper. The two external squint quoins are shown by perpendicular lines from the ground floor level to the top of the copper.

In Fig. 276 we have the elevation of the square-built brick copper, showing the face of the brickwork, width of ash-hole, also the height of the ash-hole, furnace frame and door, and soot door. The floated cement surface is indicated by horizontal thick line at the top of the copper.

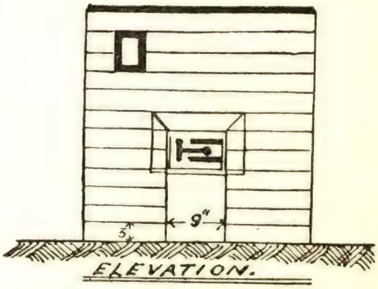


Fig. 276.

Points to remember.—One or two important points should be borne in mind in the construction of the copper. (1) The flue should be properly formed; should have a uniform bore throughout its length from the furnace bars to the main flue; should be well parged, and should be thoroughly cleaned out on the completion of the copper. If ragged edges of brick are left projecting, or material left in the flue after construction, it will retard the flow of smoke to the main chimney, and in course of time cause a blockage. A flue properly formed will heat the water in the copper much more economically than a badly formed flue. The flue should be built so as to form a heating surface practically all round the copper in a gradual rising position. (2) All brickwork should be thoroughly rendered in with lime mortar, to fill all the voids, etc., so as to prevent any smoke from escaping from the internal part of the copper. (3) A damper can be built in, in the main vertical flue. This is usually fixed at the height of 9 inches above the top of the copper. This regulates the copper fire, according to the amount of draught required; it can be pushed in or drawn outwards.

CHAPTER XIV

WINDOW AND DOOR OPENINGS

Window Openings—Sills—Relieving Arches—Construction of Relieving Arches—Gauged Arches—Jambs—Gauged Segmental Arches—Door Openings—Splayed Jamb in English and Flemish Bond—Door Openings with Rebated Reveals—Rebated Openings—Rebated Jambs.

FIG. 277 gives an illustration of the front elevation of a window opening which is 5 feet in height including the sill. Excluding the sill, which is 4 inches in thickness, the clear height opening is 4 feet 8 inches and 2 feet 9 inches in width. The top of the opening is arched over with a gauged camber 12 inches in depth on the face of it.

Sills.—The sill is shown at the bottom of the opening, the thick horizontal line showing the splay of the sill outwards, which throws the water off away from the wood window frame. The plan at the bottom of the elevation shows the course of brickwork above the level of the sill. This is in English bond with the stretcher course on the external face, and the heading course in the internal face of the wall. The stretchers on the external faces of the wall, which form the width of the opening, are the reveal bricks. A recess is shown behind these bricks, which is 9 inches by 4½ inches. The part of the sill underneath the reveal stretchers is indicated by dotted lines.

Fig. 278 gives the illustration of the back elevation of the same window opening. The clear width of the opening is 2 feet 9 inches. This is between the end faces of the reveal bricks on each side of the opening. The width of the recess, which is 4½ inches back from the end face of the reveal bricks on either side of the opening, makes this measurement at the back portion of the window opening 3 feet 6 inches in width. The recess is indicated by shaded lines. The top portion is also recessed, that is, the horizontal recessed portion at the back of the front camber arch. The depth of this portion is 4½ inches and the height 3 inches. This internal recessed portion allows the window frame to be placed into position at the back of the reveals. The back portion of the camber arch, which can be seen from the back elevation, before the frame is placed in position, is shown by shaded portion. The bottom part of the opening shows the back of the sill, the length of which extends 2¼ inches each side of the end faces of the reveal bricks. The sill is shown without any brickwork built against its back face. This is usually built afterwards when the sill and frame are fixed, according to the internal finish required.

Relieving Arches.—On the top of the opening internally a relieving arch is generally built. In recent years the reinforced concrete lintel is taking the place of the relieving arch over various-sized openings.

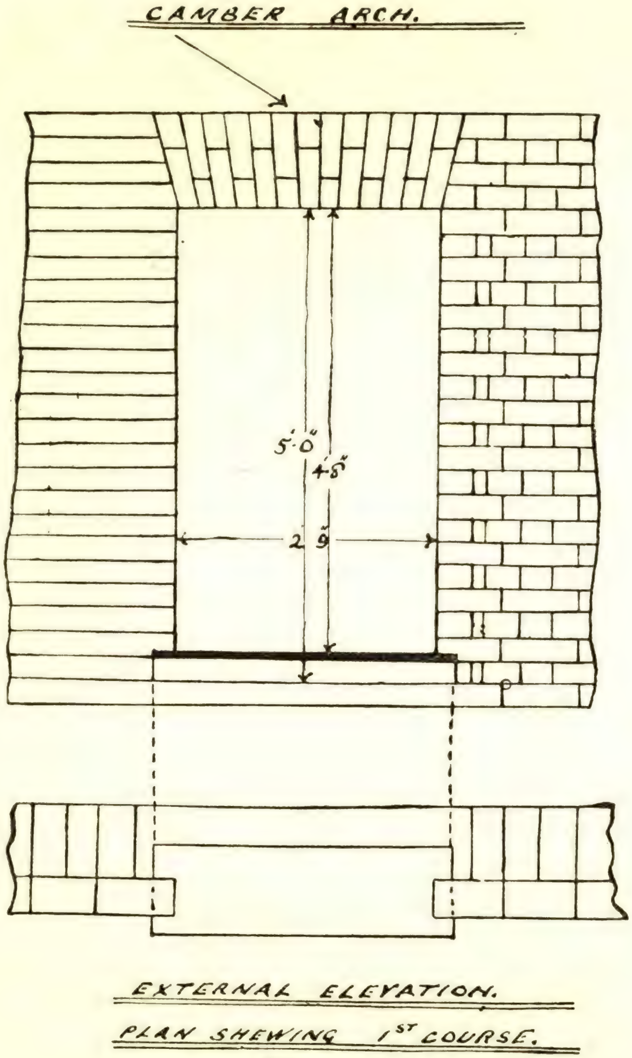


FIG. 277.

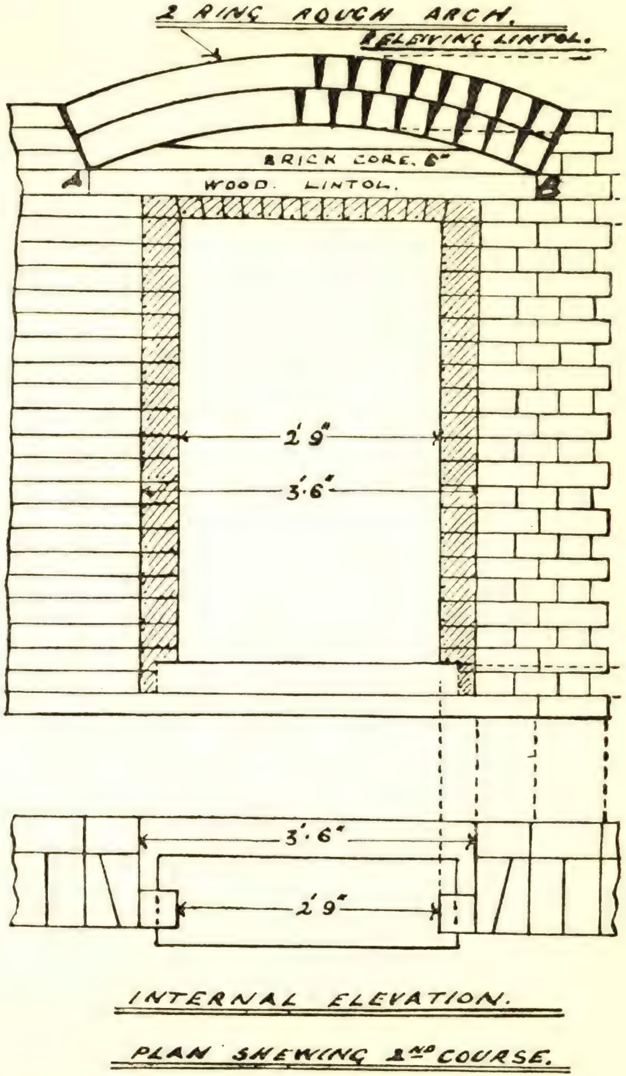


FIG. 278.

The relieving arch takes the weight of the brickwork over the centre of the door or window opening directly over the window or door frame. It is also useful in the case of fire, because a wooden lintel is liable to be burnt out. This and the brick core would probably fall away, but the relieving arch would remain in its position. Therefore, at the top of the opening in order to construct the relieving arch, a wooden lintel is placed in position and bedded solidly in a horizontally level position, the bottom of which should be 3 inches above the soffit line of the external camber arch. This should extend in length at least 6 inches on each side of the internal opening. This wooden lintel is sometimes 4½ inches by 3 inches or 9 inches by 3 inches according to the width of the internal jambs of the opening. Upon this lintel is built a brick core which usually consists of two courses of brickwork, so shaped that the top portion of it forms a segment with a 6-inch rise in the centre. This should be measured from the top surface of the lintel. The springing points at each side for this segment should be AB as shown, which are at the extreme ends of the top angles of the lintel. This segmental shape on the top portion of the core of brickwork forms the bed on which the soffit of the relieving arch is constructed.

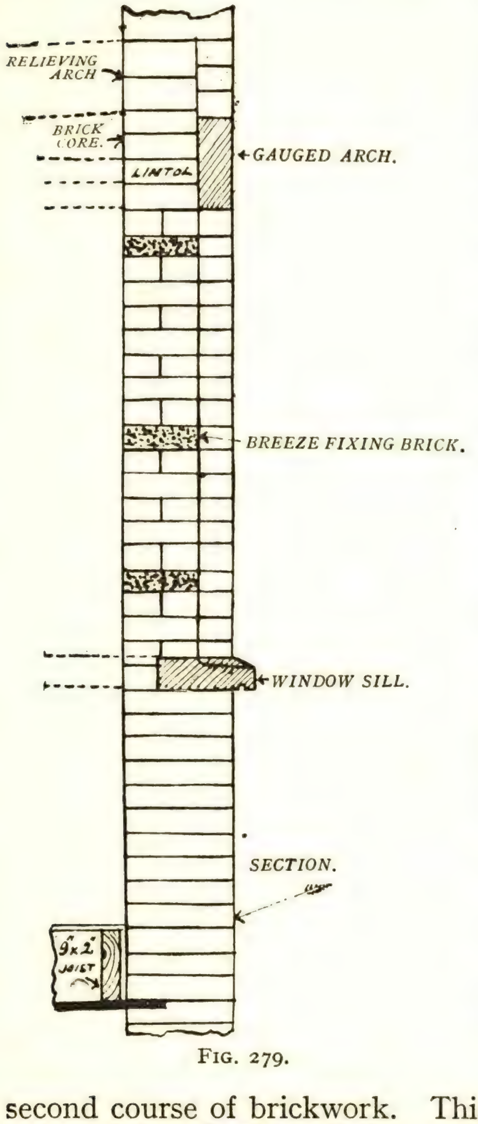


FIG. 279.

Construction of Relieving Arch.—The relieving arch consists of two rings of brickwork which should have a uniform thickness in their cross and bed joints. The whole should be well flushed and grouted in with cement grout. The plan at the bottom shows the bond in the second course of brickwork. This time the heading course forming the external face work, and the stretching course forming the internal face work, the external face work starting from the reveal half brick, consists of half brick, closer and headers along the course. The closer and header next to the reveal bat are formed by two king closers, reversed in position to each other, one forming a closer on the face and the other forming a header on the face. The width of the opening is shown between the reveal bricks, which is 2 feet 9 inches, the width at the back of the opening between the jambs being 3 feet 6 inches.

Gauged Arch.—Fig. 279 gives an illustration of the section of the previous window opening starting from the top downwards. It shows the gauged arch end of reveal bricks at side of opening and window sill on the external face; on the internal portion it shows the relieving arch, brick core under the relieving arch, wood lintel under core.

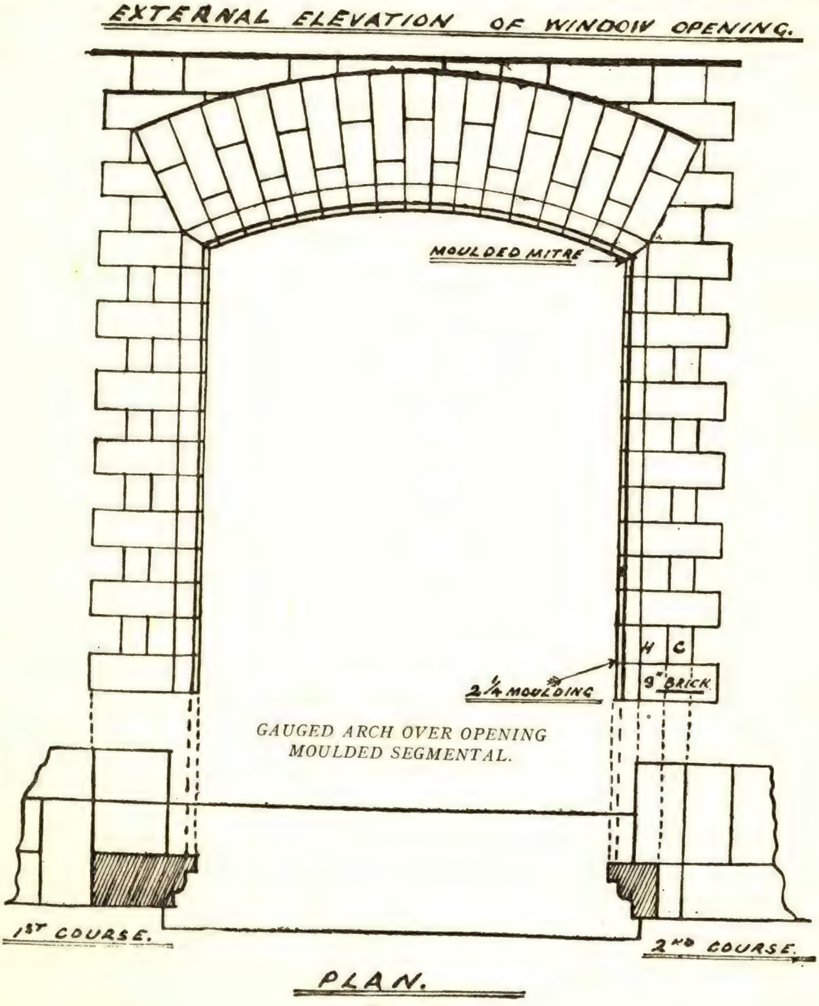


Fig. 280.

Jambs.—Lower down it shows the jamb at the side of the opening and breeze fixing bricks, built into the jamb at various distances apart. The course of bricks is shown which is built against the back of the sill. Lower down the floor is shown.

Gauged Segmental Arch.—Fig. 280 gives an illustration of an external elevation of a window opening with a gauged segmental arch at the top, with moulded soffit and face brickwork in English bond. The sides of the opening also show moulded reveal bricks. The rise of the segmental arch is 3 inches. The plan below shows the course above the level of the stone sill, and the course above that, the bond of one course being shown on one side. The bond of the next course is shown on the other side. English bond is shown on the internal face brickwork, and Flemish bond on the external face brickwork.

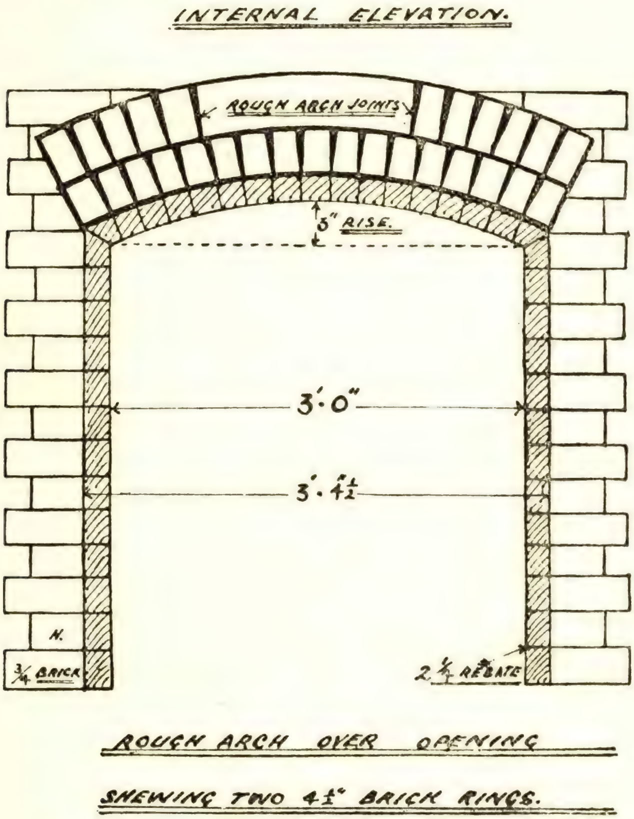
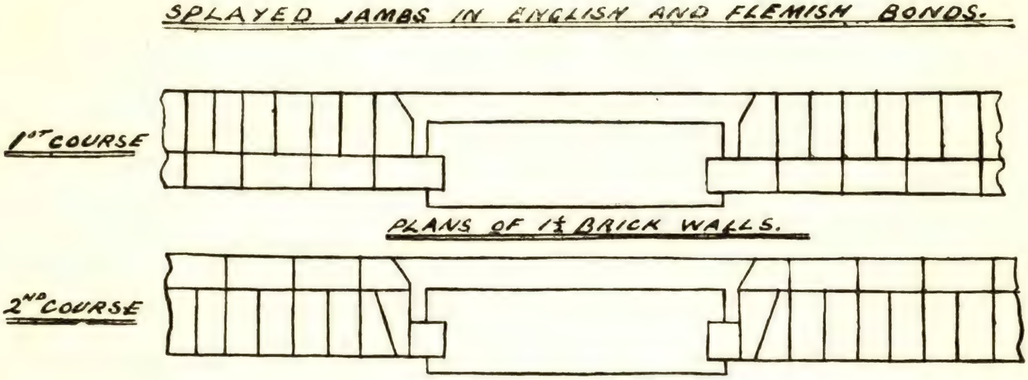


FIG. 281.

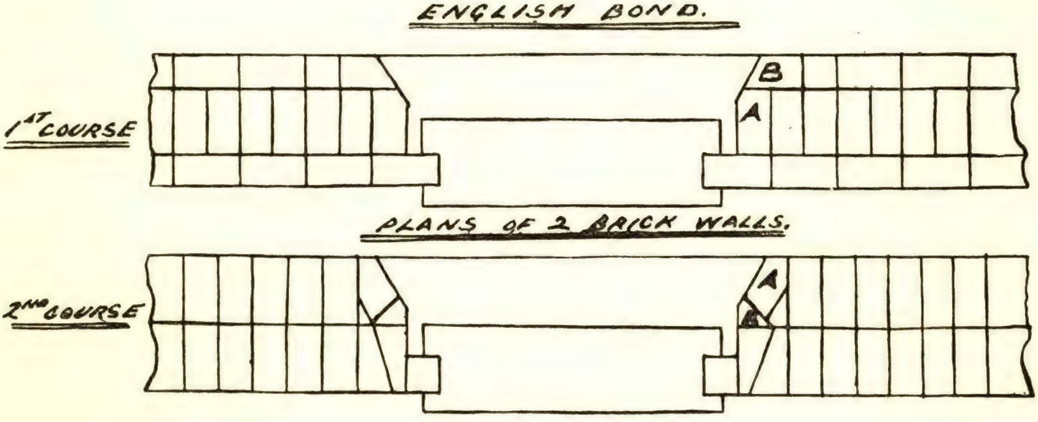
Fig. 281 gives the internal elevation of the same opening. The shaded portion at the sides of the opening shows the 2¼ inches rebate, or recess, at the back of the front face reveal bricks, while the shaded portion below the rough arch shows the back of the moulded soffit arch on the front face. This opening shows a recess or rebate all round the internal part of the opening. The spring of the rough internal arch is 2¼ inches higher than the springing of the external face gauged arch. The width of the external opening is 3 feet and the width of the internal opening is 3 feet 4½ inches.

Door Openings.—Door openings can be treated in the same manner as shown in these window openings. Concrete lintels are used at the present time for window and door openings internally and externally. The gauged or axed arch always gives a better appearance to the external face brickwork than the concrete lintel. The lintels are sometimes made the whole width of the walls to the door or window openings, at other times the gauged arch is constructed on the face of the work and the lintel is fixed at the back portion of the work. The same method applies to the rebate or recesses which form the jambs, the lintel being kept up 3 inches higher or whatever distance is required at the back of the arch to take the window or door frame.

Splayed Jambs in English and Flemish Bonds.—Fig. 282 gives the plan of window opening, showing the bond worked at each side. English bond is worked in this illustration, showing stretchers for external face work and headers for internal face work. The sill is shown projecting 2¼ inches from the face of the brickwork and 2¼ inches wider each side of the reveals on the external face work. The internal 4½ inches face portion of the jambs are splayed. Fig. 283 represents the course above the previous one, in which the bond is headers for the external face work, and stretchers for the internal face work. This again is English bond. Both of these walls are 13½ inches in width or one and a half brick.



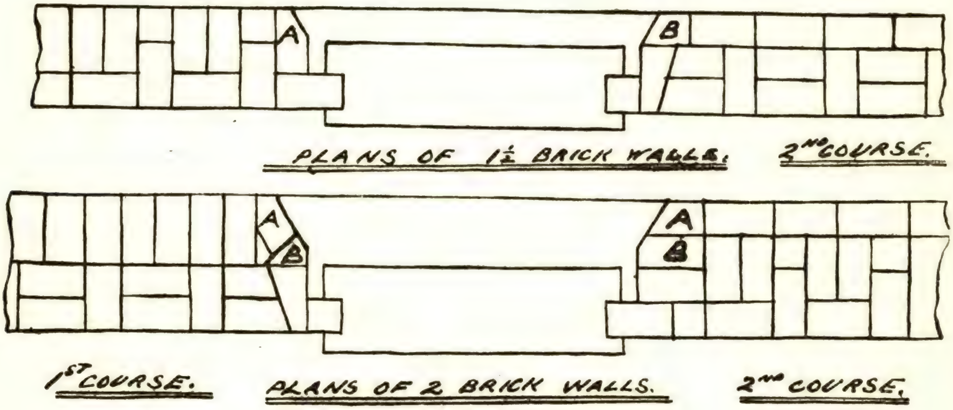
FIGS. 282 and 283.



FIGS. 284 and 285.

Fig. 284 is another illustration of the plan of an 18-inch or two-brick wall built in English bond. The first course consists of stretchers on the external and internal faces of the wall, filled internally with a course of headers. The projection of the sill is the same as in the previous illustration. The internal splay is formed with two bricks in this case, instead of one as in the previous illustration, 2¼ inches are taken of the external angle of the header marked A, and the three-quarter brick on the internal face marked B is splayed. A bat is placed next to this to form the proper sectional bond in the wall. Fig. 285 shows the plan of the second course of the two-brick or 18-inch wall, headers form both the internal and external faces of the wall. The internal splay is again formed by cutting two bricks. The brick marked A which forms part of the internal splay shows 2¼ inches on the internal face course from the splay point, and 4½ inches on the splay return; the piece marked B is formed with an angular-shaped piece of brick.

Window Opening.—Fig. 286 gives an illustration of a window opening with splayed internal jambs, the walls of which are one and a half brick or 13½ inches in width, the bond being single Flemish. The first course is shown on the left hand side of the opening and the second course on the right hand side of the opening. The first course shows headers on the internal face and the Flemish bond on the external face. The internal splay is formed by cutting A 4½ inches on the stretcher face to 2¼ inches on the header face which forms a closer starting from the internal splay point. The second course consists of stretchers on the internal face, and the Flemish bond on the external face. The splay B is formed by cutting a three-quarter brick on the return; this forms a header on the internal face from the splay point, which breaks joint with the closer on the face in the course below it.



FIGS. 286 and 287.

Fig. 287 gives an illustration of a window opening with splayed internal jambs, the walls of which are 18 inches in width or two bricks, and the bricks are laid in single Flemish bond. The left hand side shows the plan of the first course, and the right hand side plan shows the second course. Headers form the internal face course and A is formed as a closer from the splay point on the face of the wall, and B is cut angular in shape to form the rest of the splayed jamb. On the right hand side plan the stretchers form the internal face course. The splay starts with a three-quarter brick which is splayed and forms a bat or half-brick from the splay point. This breaks joint with the 2¼ inches splay piece. Below it, as shown in the first course, B is formed by cutting a corner off and splaying a three-quarter length brick, which forms another 2¼ inches on the splayed face of the jamb. The external face of the work, both in the first and second courses, is Flemish bond, half brick, king closer header, and so on. forming the left hand bond from the reveal, and a three-quarter bat, stretcher, header, etc., forming the right hand side bond on the external face.

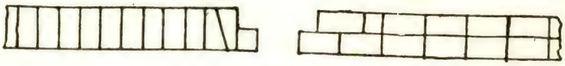
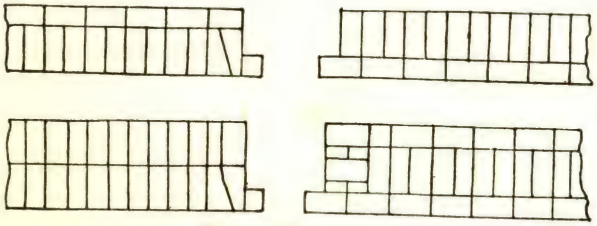


FIG. 288.

Door Openings with Rebated Reveals.—Fig. 288 gives an illustration of the plans of two courses one at each side of the door opening. The wall is 9 inches in width, with 4½ inches rebate in English bond. The left hand side shows the first course, which consists of the reveal, a half brick. Next to it the king closer and then headers continuing all along the course. The right hand side consists of the stretching course, which forms the second course, and consists of all stretchers on the face of the wall including the reveal stretcher. The internal face consists also of all stretchers, except the bat which is next to the internal corner stretcher. It is placed in this position to obtain sectional bond in the working of the stretchers throughout the length of the wall.



FIGS. 289 and 290.

Fig. 289 gives the plans of first and second courses of the one and a half brick wall, with rebates in the opening. The wall is built in English bond. The left hand side plan, which is the first course on the external face, consists of the heading course, starting from the reveal with a bat or half brick with a king closer placed next to it, and then headers continuing throughout the course. The internal face consists of a course of stretchers, except the brick on the internal corner of the jamb, which is a three-quarter brick; this forms the sectional bond with the external heading bond. The second course consists of stretchers on the external face, and the internal course consists of all headers. Fig. 290 shows two courses of the two-brick or 18-inch wall, one course at each side of the opening, which is rebated. The first course on the left consists of headers on the external face, starting with the reveal bat, next the king closer, and then all headers throughout the face course. The internal course also consists of headers, starting with header and closer and following all headers along the course. The right hand side plan consists of stretchers on the external face course, and stretchers on the internal face course, except the bat or half brick which is next to the corner jamb brick; this is in order to work the bond sectionally. A row of headers completes the internal 9 inches of the wall, except at the face of the jamb where the bricks are reversed and show two headers and two closers on this face. Fig. 291 gives the plans of the first and second courses at the sides of the opening with rebates in English bond. The walls are two and a half bricks in thickness. The first course consists of headers on the external face, starting from the reveal brick on the same method as the previous first course of the two-brick wall. The internal course consists of stretchers, starting from the corner jamb with a stretcher header and closer. The face of the jamb shows a three-quarter on the corner of the jamb, header next to it, which recedes into the wall three-quarters of the length of a brick. Next to this is a header on the face of the jamb. This is the back 4½-inch portion of the king closer, which shows as a closer on the front external face. Another course of stretchers laid internally completes the two and a half bricks in the thickness of the wall. The second course consists of stretchers on the external face course, and all headers on the internal face course, except the corner jamb brick, which forms a stretcher on the internal face of the wall; the face of the jamb, which is 18 inches, consists of three headers and two closers.

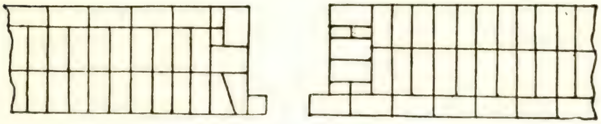


FIG. 291.

Rebated Openings.—Fig. 292 gives an illustration of the rebated opening, the walls of which are three bricks in thickness, built in English bond. The first course consists of headers, starting from the reveal with the header and closer. This completes the external face. The internal face also consists of headers, starting in the same method from the internal jamb corner. The internal 9 inches is filled in with another row of headers. This completes the width of the wall. The end of the jamb face consists of stretcher, and two headers. One header, which shows on the face of the jamb as a header, is cut as a king closer and ties in behind the reveal header; a closer is bedded behind this to fill in the space next to the row of internal headers. The second course consists of all stretchers on the external and internal faces of the wall. The internal space of 18 inches or two bricks in width is

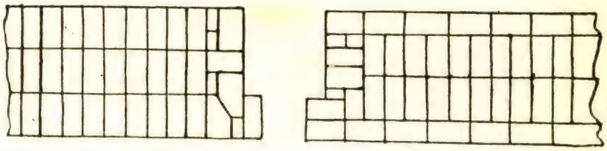
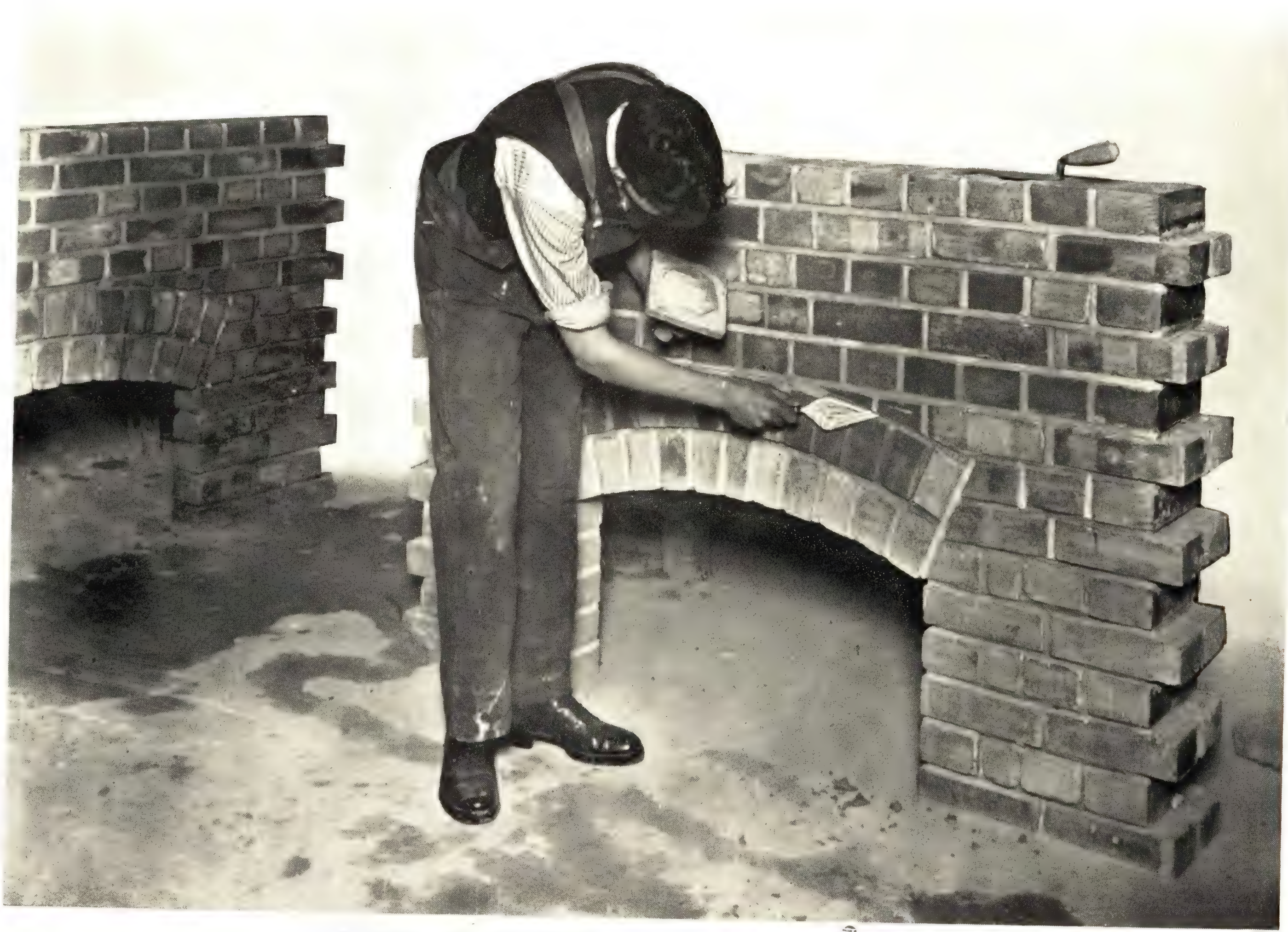


FIG. 292.

PLATE

JOINTING AND POINTING WALL WITH ARCHED OPENING

A 9-inch wall, built with Fletton bricks in English bond, containing an arch formed with two half brick rings, the ends toothed, ready for extension. Part of the wall has been pointed with a weathered joint, while the bottom portion, with the right hand pier of the arch opening as well as half the arch rings, have been left unpointed. The operative is shown pointing the top half ring of the arch, the pointing hawk in his left hand, with the pointing trowel in his right hand, the fingers and palm against the handle and the thumb pressing against the shank-end of the ferrule. The mortar having been pressed into the joint, the surface is ironed by moving the blade backwards horizontally, by which the mortar is compressed into a solid joint with a high finish, better calculated to withstand weathering than a loose, porous joint.



JOINTING AND POINTING WALL WITH ARCHED OPENING.

filled in with two courses of headers. The face of the jamb at the side of the opening consists of three headers and two closers.

Rebated Jambs.—Fig. 293 gives the plan of the first course of a wall 9 inches in thickness one side of an opening with 4½-inch reveals, the jambs being recessed back from the face of the reveal bricks 2¼ inches. The plan of first course, which is in English bond, consists of stretchers on the internal and external faces, except the corner internal jamb brick, which is a three-quarter. This is placed at the back of the reveal stretcher to form proper sectional bond throughout the whole course. The second course consists of all headers, except the reveal brick, which is a splayed bat, cut so as to form 4½ inches on the face and 2¼ inches at the back, which forms the recess. Next to it is a king closer with the 2¼-inch face showing on the external face and the 4½-inch face showing internally forming the corner jamb header (Fig. 294).

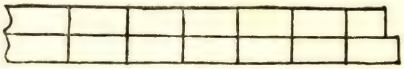


FIG. 293.

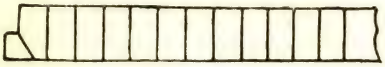


FIG. 294.

Fig. 295 shows the plan of the first course of a wall 13½ inches in thickness at one side of an opening, built in English bond, with 4½-inch reveal and recessed 2¼ inches showing a 9-inch jamb. The external face course consists of all headers throughout the course. The internal face course consists of headers and one closer; starting from the corner of the jamb we have the header and closer next to it showing on the internal face. These are formed by two king closers, one reversed to the other; one showing the 4½-inch face and the other showing the 2¼-inch face on the internal face of the wall. The second course shows a heading course on the external face work, the reveal starting with a splayed bat, which forms 4½ inches on the external face, 4½ inches on the face of the reveal, and 2¼ inches on the recess. Next to this is placed the king closer, which shows 2¼ inches on the external face, the back of which is jointed against back of the corner jamb stretcher in the internal face course, the whole of the internal face course consisting of stretchers (Fig. 296).

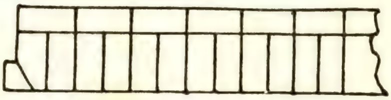


FIG. 295.

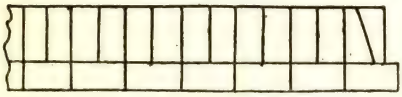


FIG. 296.

Fig. 297 shows the plan of the first course of a wall at one side of an opening which is 9 inches in width and built in Flemish bond with 4½-inch reveal and recessed 2¼ inches. The first course consists of stretcher, header, alternately throughout the course on the external face, starting from the reveal stretcher. The internal face consists of the three-quarter jamb corner brick, which gives a sectional bond

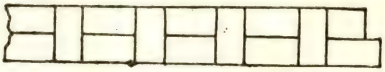


FIG. 297.

with the external reveal stretcher and also forms the 2¼-inch recess from the face of the reveal. Headers and stretchers are continued alternately throughout the course to complete the internal face course. The second course (Fig. 298) of the 9-inch wall in Flemish bond, with 4½-inch reveal and 2¼-inch recess, consists of header, closer, and then stretcher, header, alternately along the whole course. The reveal bat and king closer form the bond on the external face course, the same as the end of the opening in English bond. The internal face course consists of header and stretcher alternately throughout the course. Fig. 299 shows the plan of the first course of a wall, at one side of an opening built in Flemish bond, the thickness of the wall being 13½ inches. The end of the opening shows a 4½-inch reveal and 9-inch jamb, which is recessed back from the face of the reveal 2¼ inches. The external face course consists of stretcher and header alternately throughout the length of the course, starting with the stretcher reveal brick. The internal face course consists of header, closer, starting from the corner jamb brick; then stretcher, header, alternately form the remaining bricks of the course. Two king closers form the header and closer, which show as 4½ inches and 2¼ inches respectively on the internal face course, starting from the jamb corner brick. The second course which is placed on the opposite side of the opening consists of the reveal splayed bat, which forms the 4½-inch reveal and the 2¼-inch recess. Next to this the king closer forming the face closer; then stretcher and header alternately along the whole course. This completes the external face course. The internal face course consists of the jamb corner header, which shows a stretcher on the internal face course, then header and stretcher alternately throughout the course; the internal 4½-inch spaces are filled in with half bricks or bats (Fig. 300).

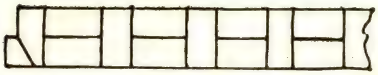


Fig. 298.

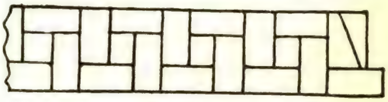


Fig. 299.

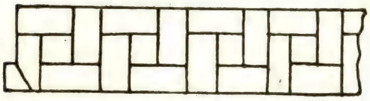


Fig. 300.

CHAPTER XV

PARTITIONS AND FLOORS

Partitions—Slab Partitions—Brick Partitions—Terra-cotta Partitions—Hollow Plaster Slabs—Reinforced Concrete—Fixing Bricks—Fire-resisting Floor Construction—Brick Floors—Brick, Concrete, and Steel—Steel and Concrete—Hollow Brick Floors.

Partitions

Partitions are constructed of various materials, viz. slab partitions, brick partitions, terra-cotta partitions, etc.

Slab Partitions.—Fig. 301 gives an illustration of a slab partition. These slabs are sometimes made of concrete, which consists of a proportion of broken brick crushed small, of sand and cement mixed together with clean water, pressed in moulds, and allowed to set. Such slabs are made in various thicknesses and are sometimes reinforced with iron bars. The small slabs are made in lengths of 12 inches to 18 inches and 9 inches by 12 inches in height, which is generally made to suit the gauge of brickwork into which they are bonded. This form of slab is also made with coke breeze and cement, the mixture being placed under pressure in various moulds. Coke-breeze slabs are made usually from 1 foot to 2 feet 6 inches in length and 9 inches to 1 foot 6 inches in height to suit the various situations for which they are required. The thickness of these slabs varies from 1½ inches to 3 inches, while the thickness of the concrete slabs previously mentioned varies from 3 inches to 6 inches according to requirements. A breeze partition is very light but is not absolutely fireproof. The concrete slab partition is fireproof but is heavy. Such partitions are very useful on ground

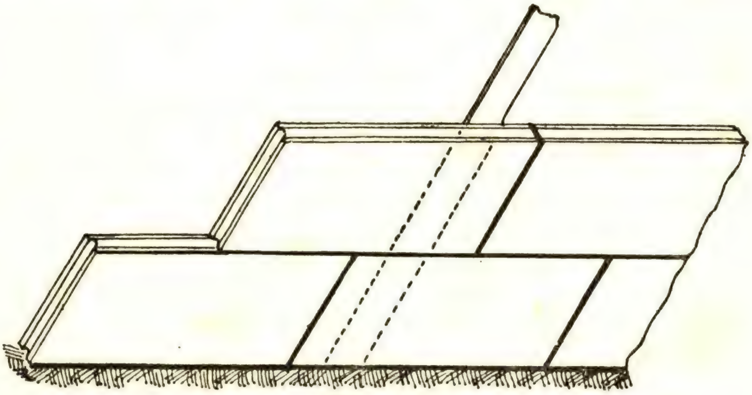
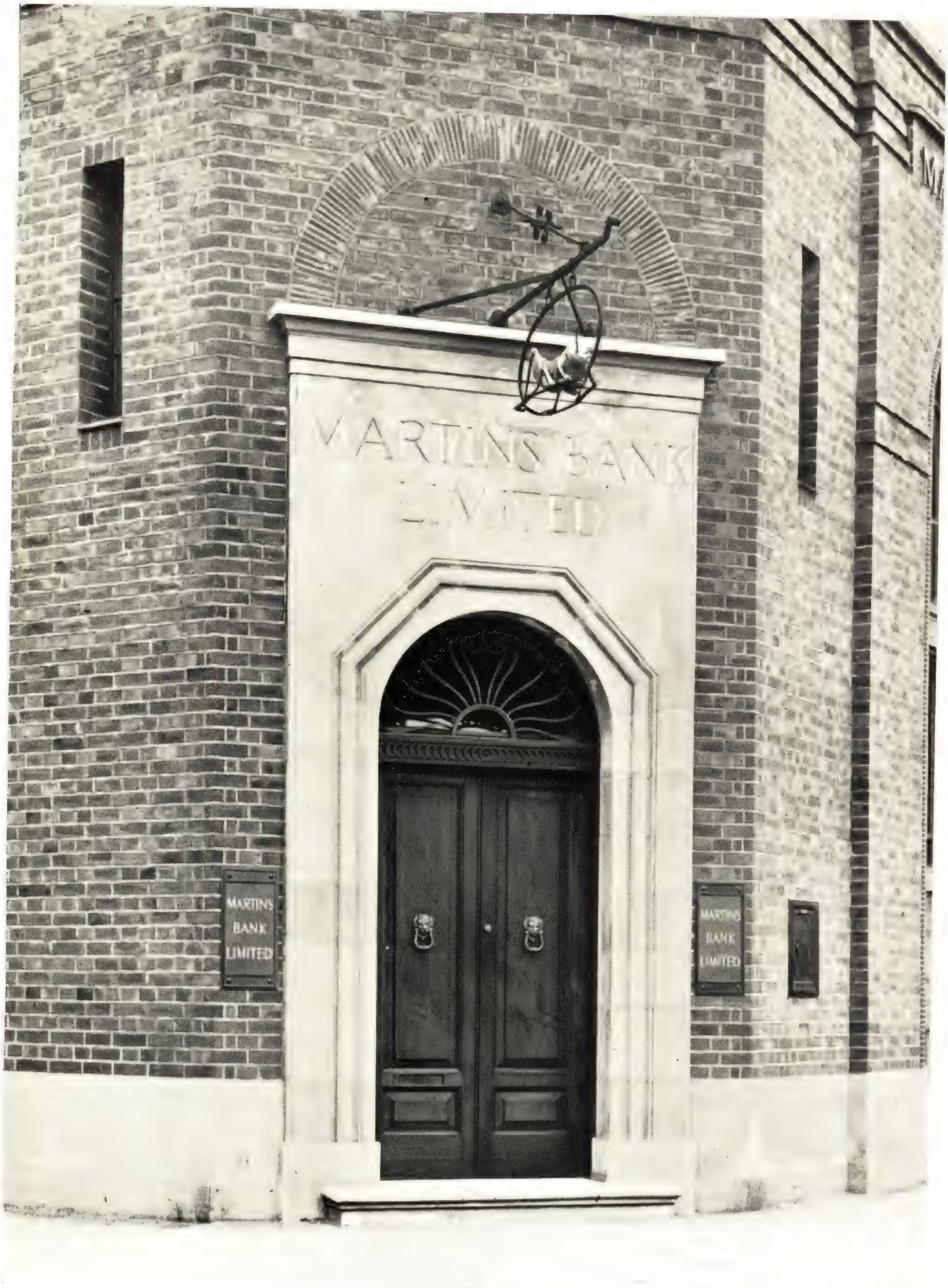


Fig. 301.

floors, providing they are of the proper thickness, while lighter partitions are placed on floors above them. Of course, concrete slabs are also used in upper floors, providing they have the necessary supports to carry them. Slabs in both these forms of partitions are usually grooved and tongued on their edges, as shown in Fig. 301.

These slabs form a good strong partition. When constructing a partition formed of either of these kinds of slabs, a good cement mortar should be used in jointing them together. The ordinary method of constructing one of these partitions is to first set out the position of the partition on the floor. This is usually marked in pencil, or with a chalked line. Sometimes a strip of wood is placed along this pencil line and temporarily nailed to the floor, to work the partition blocks against. If the partition which is to be built is of a considerable length, perpendicular profiles, consisting of pieces of 4-inch by 3-inch timber, are placed at various distances along the length of the proposed partition, the face of them placed perpendicularly with the back pencil line of the partition marks on the floor. (That is, assuming that one has drawn double lines for the proposed partitions, one for inside and one for outside face.) This upright can be temporarily nailed in position to the floor or wedged between the floor and the ceiling. These upright pieces of 4-inch by 3-inch timber steady the partition while it is being constructed, by the slabs resting against them at these various points. A piece of 4-inch by 3-inch is shown in the illustration in a perpendicular position at the back of the partition. If door openings, etc., are required in this partition, they are also marked before commencing the construction.

The bed should now be laid for the first course of slabs. If starting from the face of a wall which is at right angles to the partition, a chase should be cut in that wall to receive the ends of the slabs. This chase, or indent, should be at least 4½ inches recessed into the wall, from the face of it. The first course of slabs should be bedded with the groove of the slab placed downwards upon the cement-mortar bed. Sometimes small nails are half-driven into the floor (that is, if the floor is a wooden one), at a point which is central with the centre of the groove. These are driven in all along the length of the partition for the first row of slabs to be bedded upon. The slabs are then bedded groove downwards on a bed of cement mortar and not the tongue downwards. If the slabs are bedded with the tongue downwards, they are liable to rock, especially if the bed is on the thin side; the round tongue would then probably touch the floor and have a tendency to move one way or the other in a side movement. The nails which project from the floor in a central line with the inside and outside face of the partition are also imbedded. The slab is then pressed on to this bed of cement mortar in position. When set this bed joint in conjunction with the nails and the adhesion of the slab forms a good staple position for the slab partition at the base. It is the usual practice



ENTRANCE TO MARTIN'S BANK, BEXLEY HEATH.
Deane & Braddell, Architects.

to bed one or two slabs in the first course against the wall when we have the chase cut, and then proceed to bed one or two in the second course, and, say, for example, one slab in the third course. This forms a corner of slabbing. These courses are then vertically plumbed with the plumb rule and bob. Some bricklayers when working from a wall (which is at right angles to a partition), hold the plumb rule against the wall and make a pencil mark perpendicularly on the face of the wall. This mark forms the perpendicular face of the slab partition. The other end of the partition can now be constructed by the same method. We thus now have two corners to work to. At each corner, on the top edge of the first slab, in the bottom course, at a point near the top of the first vertical joint, line pins are inserted and the line stretched along the top horizontal edge of the slab. The first course can now be bedded, and each slab as it is laid should be jointed vertically and pushed tightly against the preceding one; this can be repeated until the whole course is laid, bedded, and jointed.

The line pins can now be taken out and elevated to the top horizontal edge of the next course and the construction proceeded with. If the partition is to be rendered afterwards with a coating of cement and sand, all the bed joints and cross joints should be left in a rough condition on the face. This is done by the bricklayer by simply pulling the trowel towards himself, at the same time holding the blade of it at right angles to the partition. This finish gives a key to the cement rendering. Sometimes a partition is started from a point where there is no wall to tie into; the end may simply be a rounded or bull-nosed finish standing alone. In this case, a profile is usually fixed temporarily at this point, in a vertical position from floor to ceiling. The height of the courses can be marked on the face of this, by horizontal pencil marks. One nail can be driven into these marks at the level of each course, and the line can be attached to these nails and the courses laid to it. This method is very often used.

When constructing one of these partitions on a ground floor, composed of concrete or cement and sand, etc., the usual practice is to mark out the partition lines back and front face, and, in order to form a key for the first course of slabs, the floor surface between the parallel lines (which mark the position of the partition) is thoroughly chipped or hacked so as to form a rough surface or key for the bed of cement mortar upon which rests the first row of slabs. Better still, sometimes a chase is made into the floor between these lines to a depth of 1 inch or more. This forms a good base and prevents a sideward movement in the partition. Having secured the base of the partition, we now have to look at the position where the partition finishes—that is, the ceiling level. If the ceiling is composed of lath and plaster finish, it is best to cut away the portion of the plaster and form a parallel recess or chase the width of the partition, to allow the partition to extend to the face of the laths, and then fix a number of wedges against the laths at a point where the ceiling joists show, between the top of the partition and the laths, which would hold the partition in a rigid position. Or if the ceiling is composed of concrete with a Keene cement finish, etc., the portion where the partition meets the ceiling would either be thoroughly hacked, or a chase about 1 inch in depth could be cut into the ceiling (providing there was sufficient depth in the ceiling so as not to weaken it). In this case a good cement joint should be put between the top of the last row of slabs and the ceiling and made thoroughly solid. This could be done as each slab was laid by the aid of a small piece of lath, which could be used to thoroughly push the cement into its position as each slab was bedded.

Brick Partitions.—Bricks form a good partition. They are fireproof, and if built with glazed bricks are very sanitary. They are generally built on the ground floor only, as they are very heavy. Glazed bricks about 3 inches in thickness, which are formed with internal hollows, and glazed on both faces, form a very good partition. They should be bedded with a good cement mortar. Glazed partitions composed of double glazed stretchers also form good partitions. These should be laid in cement mortar. They are 4½ inches in thickness. Bricks laid on their edges, bedded in a good cement mortar, and finished with cement rendering and Keene's cement, are excellent for this work. They are usually from 4 inches to 5 inches in thickness according to the amount of cement rendering on each face of the partition.

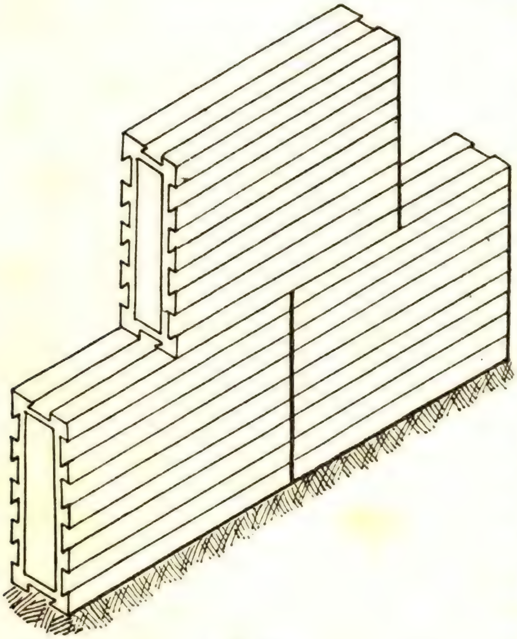


FIG. 302.

Terra-cotta Partitions.—There are also on the market various makes of terra-cotta blocks which form a good partition. These are generally formed in hollow blocks, bridged across internally with the same material. They are sometimes glazed on both faces. The thickness ranges from 3 inches to 9 inches and a foot to 18 inches or longer in length. They should be bedded in a fine cement mortar.

Hollow Plaster Slabs.—There are also hollow plaster slabs on the market which form very good partitions, but these are not generally laid down by the bricklayer.

There are also various other patent partition blocks on the market. Fig. 302 gives an illustration of a grooved partition block or slab made of terra-cotta. These grooves form a good key for the finished coat of material on the face. These are light, fire-resisting, and durable, and are made in various sizes according to requirements. There are also blocks or slabs made of pumice concrete which are used for partitions. These also are light, fire-resisting, and durable. These slabs are made under pressure and consist of a proportion of 3 to 4 parts of pumice to 1 of Portland cement. They are also made in a large variety of sizes.

Reinforced Concrete Slabs.—Reinforced concrete slabs have been used extensively of late in the construction of large balconies and galleries in cinemas and picture palaces in connection with treads and risers which partly form these structures.

Fixing Bricks.—Breeze bricks are usually built in, on the brickwork, with the object of fixing woodwork of various kinds to them. As an example, breeze bricks are bedded in the brickwork in which their faces show a perpendicular line with the jamb in order that the door frame can be fixed to them to keep it in a firm, rigid position. The same method is applied in fixing breeze bricks on the jamb face of a window opening. This form of fixing is also used for skirtings, the breeze bricks then being placed in a perpendicular position, at various distances round the room at a point near the floor level. Breeze bricks are also used for picture rail and cornice fixing. They are also built in, on the front elevation of houses, in order to secure a good fixing for tile battens where vertical tiling has to be executed. The bricks are made in various sizes from the ordinary brick size upwards. Wood pads or wood slips are used sometimes; these are built into the joints of the bricks for fixing purposes. They consist of small strips of wood usually 4 inches by 4 inches or 4 inches by 6 inches, and about ¼ inch in thickness, or sometimes smaller. These should be bedded horizontally in the joints and show on the jamb face or where the fixing is required. They should be bedded cross grained, to the direction of which the nail is to be driven. Wood bricks are used for fixing purposes, for windows and doors, but these have a tendency to shrink and become loose from the mortar beds in which they are fixed originally. They are also liable to rot in the course of a few years, especially in a damp atmosphere. Therefore the breeze brick is the best material for fixing door frames and window frames or other internal or external fixtures. They do not shrink, they take the nails well when driven, they do not rot or become deteriorated in a short time, but last for many years.

FIRE-RESISTING FLOOR CONSTRUCTIONS

Various materials are used in constructing fire-resisting floors. Concrete and steel are used largely in many forms. Terra-cotta blocks in conjunction with rolled steel joists is another form of construction, also firebrick and steel construction. A combination of concrete and steel is largely adopted on account of its adaptability in various situations. It is also employed in conjunction with a great number of floors where patent blocks of various kinds are used.

Brick Floors. — Brick is one of the best fire-resisting materials, but it is also very expensive. A 9-inch or 14-inch wall built in good mortar and every course thoroughly flushed in with grout mortar can be said to be fireproof. Again, firebricks, when properly laid in various structures, are absolutely fireproof, but are very costly. Fig. 303 gives an illustration of the section of a fire-resisting construction of a floor, a system introduced by Doultons of Lambeth. It consists of steel and hollow bricks. Rolled steel joists are placed in positions parallel distances apart from each other about 3 feet 6 inches to 4 feet centre to centre. The joists are filled in between by a number of hollow bricks, which are built in the form of a flat arch. The springer blocks fix into the bottom of the rolled steel joists and form a skewback for the intermediate blocks to rest against; the middle block is in the form of a wedge; centering is usually fixed for the blocks to be built on. When all the blocks have been placed properly in their positions, they are thoroughly grouted in at the joints between each block, as shown by arrow indication, the dovetailed indents forming a good key for the grout material and the blocks. The soffits of the blocks are also dovetailed. This forms a good key for the material which is to form the ceiling finish in the room below. After the grouting has reasonably set, a covering of concrete is placed on the top of the blocks to a level with the top of the rolled steel joists. The top of this can be finished with a cement rendering of 1½ inches in thickness or finished with tiles, or a boarded floor. When the whole of this construction has reasonably set, the centering can be taken away from the soffits of the tiles. This method of construction forms a very good fire-resisting floor and is also of considerable bearing strength.

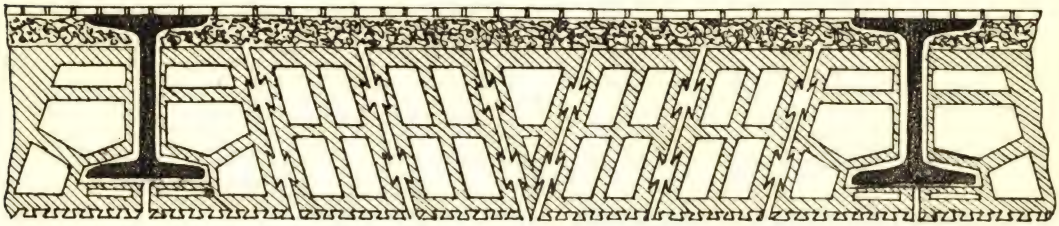


FIG. 303.

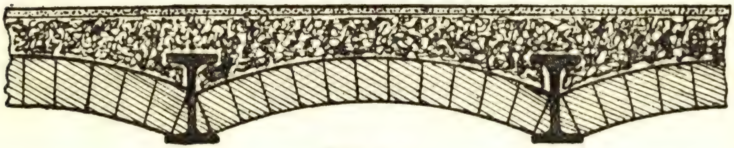


FIG. 304.

Brick, Concrete, and Steel.—Fig. 304 shows a section of a fire-resisting floor construction consisting of brick, concrete, and steel. This consists of rolled steel joists placed parallel to each other at a distance of 3 feet apart. The section shows the ends of the rolled steel joists and the brick arch resting on the bottom flange of each. A wedge-shaped brick is placed on each bottom flange, which forms the skewbacks to the arches. The arches are built of whole bricks in half bond, and being laid on their edges are therefore 4½ inches in depth. The arch is built on a wooden centre. The joints of the arch should be made solid and uniform in thickness throughout. The whole of the weight of these floors is distributed from the crown points of these arches, therefore the bricks at each side of the key should be jointed with great care. The whole should be thoroughly grouted in to make sure of any hollows which might exist being filled in solidly. Concrete can now be placed on the arches (after they have had a reasonable time to set properly), to a level about 6 inches above the top flange of the rolled steel joist. The top surface can be finished with tiles, or a 1½-inch layer of good cement and sand. This is also a good construction of a fire-resisting floor ; the only drawback perhaps is the uncovered soffit of the rolled steel joist. The centering can be taken away from the soffit of the arches, after the floor construction has had time to set reasonably.

Steel and Concrete.—Fig. 305 shows a section of a fire-resisting floor construction consisting of rolled steel joists, steel decking, and concrete. These floors are usually 15 inches to 18 inches in depth, and carry a great weight. They are generally constructed for warehouses where the floors are required to carry a great weight. Fig. 305 shows a section at the end of the steel troughs. The other ends of these troughs rest on an angle plate which is attached to the web of an 18-inch rolled steel joist ; both ends rest on a similar ledge. The troughs are bolted in position, as will be seen in the section, one being in a reverse position to the other. The bottom layer of concrete is placed in position on centering which is fixed for the purpose. The top troughs have a vertical bolt in the centres which is fixed into this layer of concrete. When this concrete is set the shuttering is taken away. Sometimes these vertical bolts are attached to concrete blocks which form the ceiling below. The whole steel decking is usually covered with a layer of pumice or light concrete to a level about 1 inch above the 18-inch rolled steel joist. Above this concrete a layer of good cement and sand can be laid to form a finished floor, or a cement screen can be laid in preparation for a wood-block floor. These are

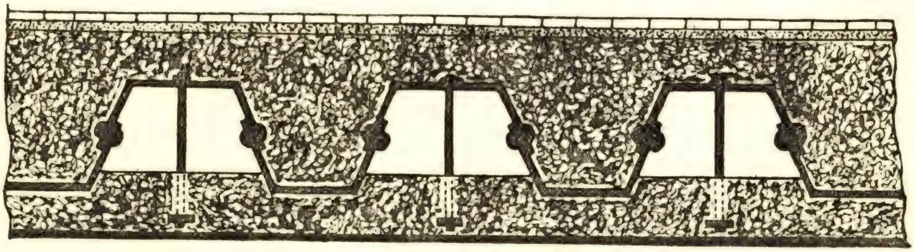


FIG. 305.

good fire-resisting floors and carry great weight. These are Lindseys' fireproof floors.

Fig. 306 gives an illustration of a Fox & Barrett fire-resisting construction of a floor. This chiefly consists of steel and concrete. The end section on the left hand side drawing shows the square steel bars resting on the bottom flanges of the rolled steel joists; these joists are placed at certain parallel distances apart. The soffits of these rolled steel joists are covered with 2 inches of concrete, the bottom of which is shuttered; the horizontal bars and the rolled steel joists are all covered with concrete to a height of 3 inches above the top flange of the rolled steel joists. Fillets of wood are bedded in this concrete; these are 4 inches by 3 inches. These form supports for the boards to be nailed to and project above the top surface of the concrete about 2 inches and form a space between the top surface of the concrete and the soffit of the floorboards. The right hand side drawing shows the longitudinal section of this floor, the longitudinal section of the R.S.J. is shown and also the square steel bars which are bedded in the concrete, also the wedge-shaped fillets on which are fixed the floorboards (Fig. 307).

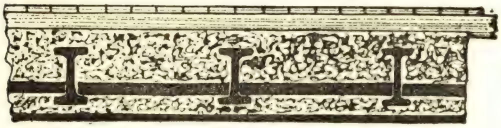


FIG. 306.

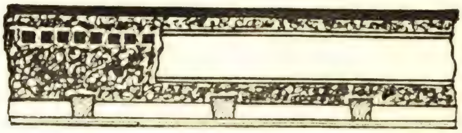


FIG. 307.

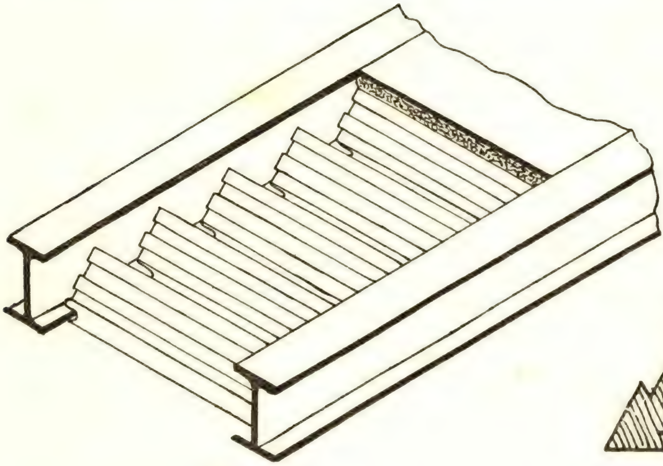


FIG. 308.

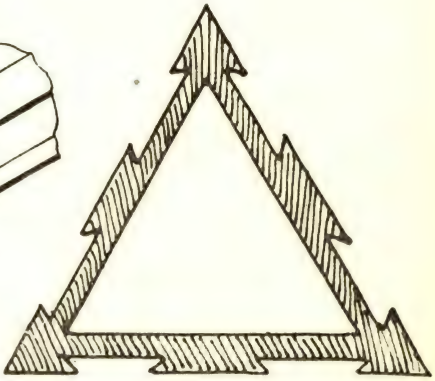


FIG. 309.

Hollow Brick Floors.—Fig. 308.—Homan & Rodgers have a very good fire-resisting floor construction in the form of hollow brick, concrete, and steel. Fig. 5 gives an illustration of this floor, which consists of rolled steel joists 3 inches by 6 inches placed at parallel distances apart of 18 inches or $18\frac{1}{2}$ inches. The hollow brick or lintel is about 1 foot 6 inches in length or spans the distance between the R.S.J.s and rests at each end on the bottom flanges of the R.S.J.s which are triangular in shape. The end bases of these tiles are recessed so as to fit into the flange of the rolled steel joists. A detailed section of one of these tiles is shown in Fig. 309. The base and the two sides of the brick tile are dovetailed. This forms an excellent key for the concrete when placed in position above the tiles, and the base dovetail forms a good key for the ceiling material in the room below. The concrete filling on the top of the tiles can now be proceeded with and filled to a level with the top flange of the rolled steel joist. Battens and boards can be placed on this to form the finished floor.

There is a very large variety of this form of brick tiles on the market, which are formed in various shapes, and span the distance between the rolled steel joists.

CHAPTER XVI

WINTER BRICKLAYING

American Practice—Bricks and Bricklaying—Protection—Tarpaulins—Mortars—Cost of Winter Work—Standard " Freezing Weather " Specification Clause—Swedish Experience.

MOST specifications in this country disallow bricklaying in frosty weather or otherwise provide stringent measures for work carried out in cold weather, giving powers to the architect to condemn such work, have it pulled down or otherwise made good at the contractor's expense.

It is nevertheless a fact that in some countries with colder and even damper climates than our own, winter bricklaying is carried on successfully. This is seen in Holland, though it is particularly the case in America, where brick building on commercial and other large structures is quite common in winter, though on small houses the necessary precautions are, as a rule, considered too troublesome and expensive if good work and durability are aimed at, though this opinion is being modified.

AMERICAN PRACTICE

The following notes give in brief outline the common practice in the United States, as given by Mr. Ralph P. Stoddard, Secretary-Manager of the Common Brick Manufacturers Association of America and the Engineering Society of Wisconsin.

Bricks and Bricklaying.—The mortar selected for winter work is lime-cement mortar (not more than 15 per cent. of lime is considered best), as quick setting is deemed essential, both to avoid possible deterioration by action of cold and to prevent displacement of bricks due to load on the soft bedding. The bricks selected have a fairly high absorption because such bricks hasten setting of mortar by withdrawal of excess moisture.

Preliminary wetting of bricks is done with tepid, not cold or hot water, and should not be excessive, so as to preserve the natural absorptive qualities of the bricks in order to hasten proper binding and setting.

Protection.—Great care is taken in protecting the walls both during construction and while work is suspended. Auxiliary scaffolding is used so as to permit of the fixing of wind screens (generally tarpaulins or waterproof canvas), to protect both the bricklayers and the walling. On the scaffold platform, within the screen, salamanders or other suitable iron stoves are placed at reasonable distances and fed with slow-burning coke. Under such conditions the setting is quite effective, sufficiently rapid to afford protection without lessening good bonding.

Tarpaulins.—On ceasing work the fresh walling is carefully protected both at top and on face by spreading tarpaulins. Should there be a fall of rain or snow, steps are taken to prevent moisture reaching the brickwork. This clearing of snow is one of the possible sources of extra cost.

As regards tarpaulins, the following is a typical specification:

"Covers to be made of 12 oz. U.S. Standard Army duck 28½ inches wide, to be 20 by 20 feet finished size and shall measure full size without stretching upon delivery. All sewing to be two-row lock-stitched with six stitches of five-cord soft finish thread, or heavier, per inch. Seams to be at least 1 inch wide. A 2-inch hem to be sewed over a ¼-inch pure manilla rope all around the four sides of the cover.

"Each cover shall be provided with a ⅜-inch rope step 6 feet long after splicing at each corner and shall have three additional stops on each side between two corner stops. All stops to be whipped on the free end and to be spliced through a sewed-in ring. Place extra sewed-in rings in the hem midway between the above stops. All covers shall be made with five 6-inch square patches sewed on to one side of the cover. One of these patches shall be placed in the middle of the cover and the other four patches shall be placed one each midway between the centre patch and each corner of the cover. To each patch shall be sewn a 1½-inch galvanised iron ring."

This will give a fair idea of the importance attached to weather protection.

Mortars.—The Engineering Society of Wisconsin in collaboration with the National Lime Association of America carried out a long series of laboratory and practical tests on mortars, with comparisons of hot and cold weather behaviour. Seven mortars were selected for final testing, and the results obtained on four tests with four samples in each case. The following are the mixes, the quantities being cubic feet: (*a*) cement 1, sand 3; (*b*) cement 2, lime 1, sand 9; (*c*) cement 1, lime 1, sand 6; (*d*) cement 1, lime 1½, sand 7½; (*e*) cement 1, lime 2, sand 9; (*f*) cement 1, lime 2·3, sand 10; (*g*) cement 1, lime 4, sand 15; (*h*) lime 1, sand 3; bricklayers' cement mortar, 1 part cement to 3 parts sand. The shear test of mortars used in cold atmosphere gave the following results: (*a*) 30 lb. per square inch; (*b*) 30 lb.; (*c*) 34 lb.; (*d*) 14 lb. (*e*) 17lb.; (*f*) 8 lb.; (*g*) 4 lb.; (*h*) 3 lb.; bricklayers' cement mortar 13·2 lb. While (*b*) gave the best results as to strength, other things had to be taken into consideration. A good mortar must be smooth, spread well, and work easily. Under all-round tests the (*e*) mix was found to be the best. In practice, for large quantities the mix can be made up on a basis of 3 sacks of Portland cement, 5 bags (of 50 lb.) of hydrated lime or 1 barrel (180 lb.) of quicklime, and 1 cubic yard of sand for each yard of mortar. For smaller quantities, the basis may be 1 sack of Portland cement, 2 bags of hydrated lime, or ¾ bushel of quicklime, and 55 shovels of moist sand.

Cost of Winter Work.—It is argued that, apart from interest on capital outlay on auxiliary scaffolding and tarpaulins, and depreciation thereon, winter work is little, if any, dearer than warm-weather work. There is, of course, the expense of the coke fires, the laying on and removal of the tarpaulin protection. As against this, it will be found that the men do more work per hour, as activity in the cold weather, with the reasonable protection afforded as described above, is natural. At all events, the extra cost involved is so small that it is counterbalanced by the advantages of all-year-round work, which automatically lessens standing overhead charges. The benefits secured by contractors dealing with big jobs have been so considerable in America that attention is being turned to the practicability of its general application to small house building, where the problem is of the greatest importance.

STANDARD "FREEZING WEATHER" SPECIFICATION CLAUSE

In America the Standard Specification clause for bricklaying in hard winter weather runs to this effect: Materials used in concrete, brick and stone masonry, plastering or other work subject to freezing, shall be properly heated by approved methods when the temperature is below 33 degrees Fahrenheit. Any work damaged by freezing shall be torn out and replaced at the contractor's expense and new work shall not be placed in contact with such damaged portions. The proper precautions shall be taken, however, to enable the work to proceed without interruption, if possible. *Temporary Heat.*—The building contractor shall provide all the temporary heat and make all other provisions, such as temporary covering for door, window, and other openings, which may be required for the performance, completion, and protection of his work against cold, until the building is completed, all subject to the approval of the architect.

In Holland, essentially a brick country, with a markedly cold and damp climate, winter building is fairly general and is deemed economically sound practice. The precautions taken against damage by frost approximate to those adopted in America. The work of Dutch bricklayers is being emulated further north with certain notable variations.

SWEDISH EXPERIENCE

A great deal of winter building is carried on in Sweden, under very severe weather conditions. For this a special mortar is used, commonly produced in bulk by manufacturers who convey it ready gauged in heated lorries to the building site. The main point is that the mortar contains a percentage of unslaked lime, which, on being gauged, generates heat sufficient, with due care, to put off freezing until the mortar has had time to set. The work of laying the bricks is carried out surrounded by the usual precautions of tarpaulin wind screens, coke stoves, and tarpaulins or sacks to cover the work. Part of the lime is obtained from ground-up sea shells and together with the unslaked lime is mixed with fine sand. It is said that a very large amount of building is carried out under these conditions, notwithstanding the hard weather generally experienced. Obviously the danger of the system lies in the temptation to use an excess of quick-lime in order to generate as much heat as possible and so ward off freezing, but with the chance that slaking would be so slow and imperfectly distributed (especially in the depth of the walling) as to result in blowing and so lead to the disintegration of the mortar. This risk appears to be overcome by careful dosage, mixing and bedding.

CHAPTER XVII

SAND COURSES

In many cases when erecting a wall it is necessary to make provision for subsequent additions, such as a flight of steps, steel joists for floor construction, even for ornamentations. Under certain circumstances the most convenient way of doing this is the laying of brick courses bedded in dry sand instead of mortar. This is a temporary measure, the bricks later being taken out and the ends of steps, joists, etc., inserted and properly bedded in mortar for permanency.

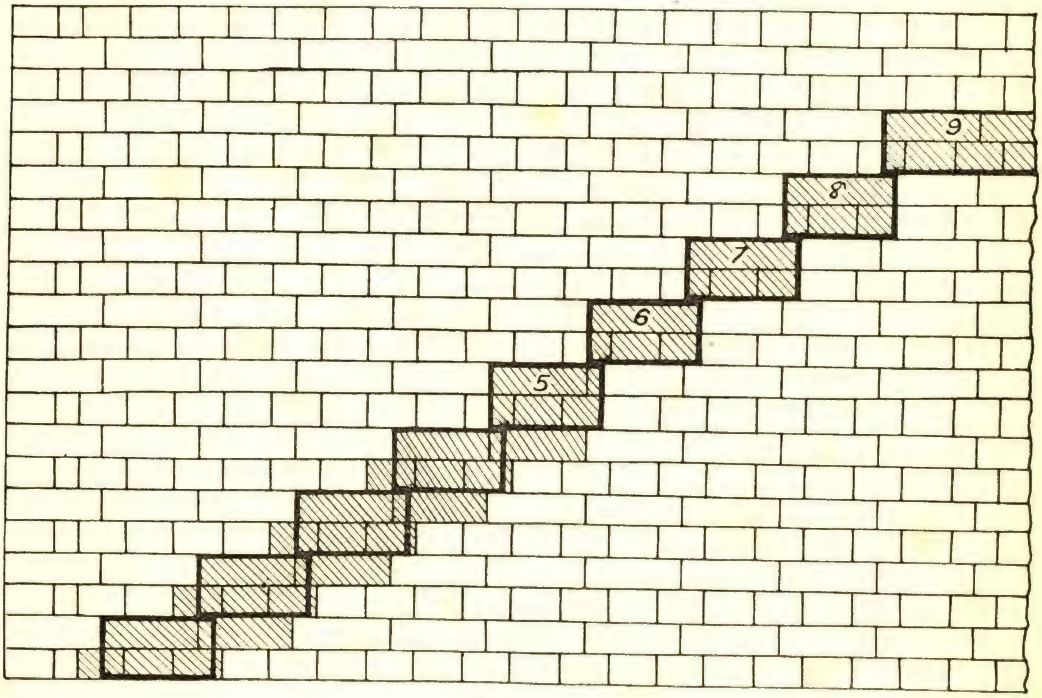


Fig. 310.

In Fig. 310 we have the elevation of a wall in English bond with section of a flight of steps marked by heavy black lines. The positions of the sand courses for these steps are indicated by hatched lines. It will be seen that as regards the first four, lower, steps, the sand courses actually extend beyond the steps, this not being the case with numbers 5, 6, 7, 8 and 9, the landing. This extension of the sand course beyond the space absolutely necessary for the step ends is to obtain correct bond. If worked exactly to the size of the steps, very small pieces of bricks, less than quarter bats in many cases, would be required to make good when the steps were placed in position. The brickwork round the steps 5 to 9 is easily made good as shown. It would be otherwise with the lower steps, so instead of placing a small piece at the front end of the lower course for the lowest step, a three-quarter bat has been used. This also applies to the stretchers for the first four steps.

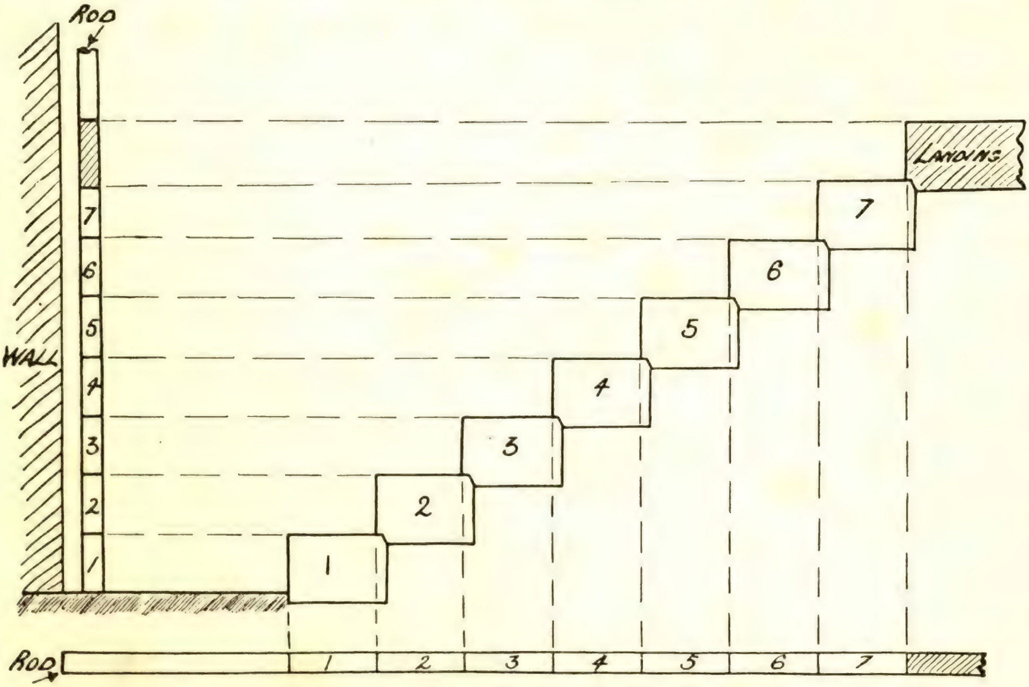


FIG. 311.

If this method of temporarily filling in the indents were not adopted, it would be necessary to cut them out of the solid brickwork when the staircase had to be erected. This would entail much delay, expense and disturbance to the rest of the brickwork.

On large buildings there may be many staircases to be dealt with in this way, and they have to be marked out accurately. This is usually done by preparing a template giving the required height and length for the steps from one floor level to another. Or rods may be used.

Fig. 311 shows the section of a short flight of steps from floor level to landing, the position and dimensions of the steps being set out by means of rods. The better to explain the method, an end wall has been drawn on the diagram. When setting out the steps a marked rod is placed horizontally abutting against the wall. The marks give the exact length of the steps. The position of the steps can be marked vertically on the wall by means of the plumb rule and line. Another way is to fix the first, or lowest step, and then use the marked rod as each new step is placed in position, taking care that the face of the step corresponds exactly with the mark on the rod. For example, when No. 4 step is placed into its correct position, it can be finally tested by applying the rod at the horizontal level, and seeing that No. 4 mark on the rod corresponds exactly with the vertical face of No. 4 step. The risers of each step can be tested in the same way by trying the marked rod each time a step is placed in position. A second rod is placed on the side of the step and the mark should correspond exactly with the horizontal top surface of the step. Alternatively the rod can be firmly fixed against the wall and each riser mark levelled from the rod to the corresponding step by means of the long spirit level. This process of taking levels is indicated by the broken working lines from the marks on the vertical rod to the horizontal surface of each tread in the flight. This method of using the rods greatly simplifies the operation.

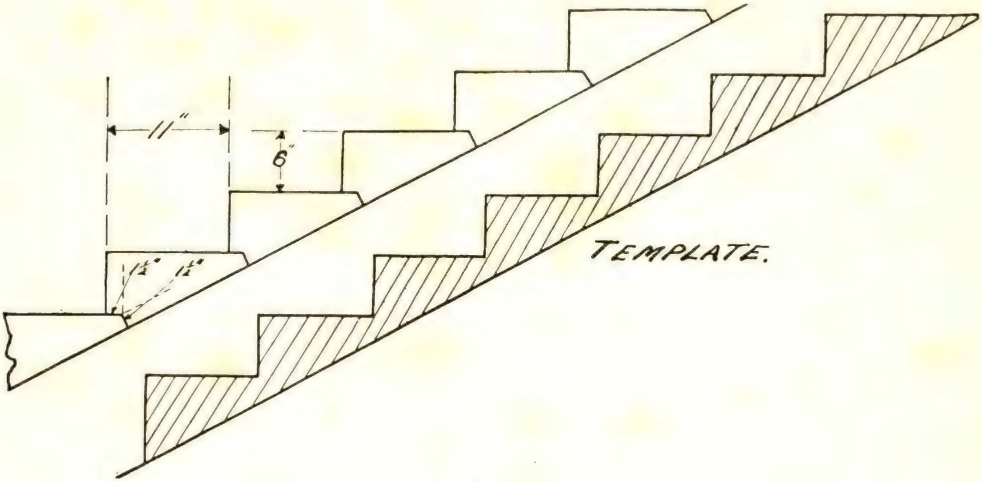


FIG. 312.

The landing is shown on the rod by hatched lines, and this portion should correspond with the exact horizontal level of the stone landing when it has been finally fixed in position.

The flights described above have steps showing right-angle soffits, but more commonly a soffit with an unbroken line is required, and the section of such a flight is shown in Fig. 312. In this case the treads are 11 inches wide and the risers 6 inches. In setting out such a flight a wooden template, giving the exact shape and dimensions of the steps, may be used. Such template is placed in position at the side of the proposed wall and the sand courses built in position, in accordance with the template, as the wall rises. The template being close to the wall the sand courses can be easily judged, both as regards length and height. Care must be taken to place the template in its correct position for the steps, and the angle of such steps. These particulars must be taken from the plans and section drawings.

As regards sand courses for the reception of concrete floor slabs, beams or joists, their positions are usually defined by the use of the marked rod. The positions of the floors and their thickness are marked on the rod, together with ceiling and floor levels. For example, if the sand courses were required for the future installation of a floor composed of rolled steel joists and concrete, a suitable rod would be obtained and upon it would be marked the level of the ground floor's finished surface ; from this a distance would be taken and marked on the rod, such distance being equal to the height from the ground floor to the finished ceiling level of the first floor, while a further mark would indicate the thickness of the floor (that is, the distance from the finished ceiling level to the finished floor surface). This rod can then be placed in a vertical position against the wall and the position of the floor ascertained. This would give the precise position for the sand course The depth of a sand course of this kind is usually equal to the width of a half-brick. The positions for the various fixtures are also taken from the plans and working drawings.